Georgia Wheat Production Guide

2022-2023

UNIVERSITY OF GEORGIA
EXTENSION

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Introduction

Richard Roth

Wheat Production in Georgia

Over the past 10 years Georgia has seen planted wheat acres range from a low of 160,000 to a high of 430,000 and harvested acres range from 50,000 to 360,000 (Table 1). The 2021-2022 season showed a drop in both planted and harvested wheat acreage of 10,000 and 15,000 acres respectively, when compared to the 2020-2021 growing season. Both planted and harvested acres for 2012-2022 were greater than the five-year average, but fell short of the ten-year average primarily due to high production years in 2012-2013 and 2013-2014.

State average yield data is not currently available from the USDA for the 2021-2022 crop. However, looking at trends in yield data over the previous nine year shows that the four-year average yield between 2017-2018 and 2020-2021 was three bushels greater than the nine-year period from 2012-2013 to 2020-2021. If you compare the 2017-2018 to 2020-2021 average yield (55 bu/ac) to the four-year average immediately preceding this period (2013-2014 to 2016-2017: 46 bu/ac), we observe a 9 bushel increase in average yield between the two time periods.

Table 1. Planted and harvested acres with state average yields for Georgia over the past 10-years as reported by the United States Department of Agriculture National Agricultural Statistics Service.

Year	Acres Planted	Acres Harvested	State Average Yield
2022	210,000	95,000	
2021	220,000	110,000	56
2020	190,000	85,000	55
2019	150,000	50,000	56
2018	200,000	70,000	54
2017	160,000	70,000	47
2016	180,000	110,000	46
2015	215,000	145,000	43
2014	300,000	230,000	49
2013	430,000	360,000	60
5-year Average	194,000	82,000	55†
10-year Average	225,500	132,500	52‡

†This represents a four-year average between 2018 and 2021
‡This represents a nine-year average between 2013 and 2021

Preparing for the 2023 Crop Year

When preparing for the upcoming wheat season please account for the following considerations:

1. Remember, wheat responds best to some form of deep tillage. Preparing land well in advance of planting allows for timely seeding once conditions are right for germination. Try to coordinate planting with rainfall events to ensure adequate soil moisture and maximize emergence. Optimal wheat planting windows in Georgia are generally within one week before or after the average first frost date for a given region.
2. Fall tillers account for approximately 85% of wheat yield potential. Therefore, a portion of your nitrogen fertilizer (approx. 15-40 lbs, dependent on previous crop) should be applied at or shortly after planting to support fall tiller production.
3. Choose varieties with good disease resistance, stalk strength, and yield potential for your area. Pay close attention to resistance ratings in variety characteristic tables if fusarium head blight (FHB) is a concern, as resistance is limited in current varieties. Weather conditions during the flowering stage are the key controller of FHB occurrence in wheat.
4. Starting with a weed-free seed-bed and be prepared to control weeds early. Timely planting allows for early herbicides applications to maximize weed control.
5. Scout early and scout often. Watch for bird cherry-oat aphids, which are the primary vector of Barley Yellow Dwarf Virus (BYDV). To help prevent BYDV infections, consider insecticide applications should when aphids reach threshold.

Recommended Wheat Varieties: 2022-2023

Daniel Mailhot

One of most difficult and important decisions a grower must make regarding successful and profitable wheat production is choosing appropriate wheat varieties for their production systems. Wheat characteristics should be assessed based on an individual basis (region, field, and management practices) due to the number of differences amongst varieties. To reduce risk and improve chances of success, it is recommended that growers plant multiple varieties each season. The 2022-2023 recommended wheat varieties for the Piedmont and Coastal Plains Regions of Georgia are shown in Table 2 and Table 3, respectively. Be sure to consider all notes regarding regional adaptation, disease, and insect susceptibilities.

Table 2. Yield and Characteristics of recommended wheat varieties in the Piedmont Region of Georgia for the 2022-2023 growing season.

2022-2023 Piedmont Region Wheat Recommendations								
Variety[1]	AVG. Yield[2]	Maturity	Susceptible to Hessian Fly	Fungicide Recommended	Leaf Rust[3]	Powdery Mildew	Septoria Leaf Blotch	Fusarium Head Blight
SH 5550[6]	111.7	M	N	Y	0	0	1	-
USG 3329[4]	111.3	M-E	N	Y	7	0	1	-
#BULLET	110.3	M-E	N	N	2	0	1	-
*SY 547[5]	108.9	M	Y	N	5	0	0	-
Dyna-Gro 9811[5]	107.0	M-E	Y	N	3	0	1	1
Dyna-Gro 9002	107.0	M	N	N	6	0	1	-
Dyna-Gro Plantation	107.0	M-E	N	N	0	0	1	-
*LW2848	106.7	M-E	N	N	2	0	1	1
*AM 473	106.5	M-E	N	N	5	0	0	-
*USG 3536[4]	106.1	M-E	N	Y	3	0	0	-
*USG 3539 5	105.5	M-E	Y	N	5	0	1	-
Go Wheat 2032[4]	104.5	M-L	N	Y	0	0	6	-
AGS 4023	104.0	M	N	N	-	-	-	-
AGS 2024[4]	103.8	M-E	N	Y	0	0	4	-
AGS 3026[5]	103.6	M-L	Y	N	-	-	-	-
#TURBO[5]	102.6	E	Y	N	3	2	1	5
Dyna-Gro Blanton	102.6	M	N	N	0	0	4	-
AP 1983	101.8	-	N	N	-	-	-	-
AGS 3040	101.7	M-L	N	N	0	0	0	3
Johnson[4]	101.4	M	N	Y	5	0	3	-
AGS 2021	100.5	M	N	N	-	-	-	-
Dyna-Gro 9701[4]	100.5	M-E	N	Y	-	-	-	-
AGS 4043	100.4	M-L	N	N	-	-	-	-
*USG 3640	99.8	M	N	N	0	0	4	-
USG 3752	99.7	M-L	N	N	-	-	-	-
Pioneer 26R45	93.3	M	N	N	4	0	0	2
*SY Viper[5]	92.4	ML	Y	N	5	0	0	2
*Pioneer 26R41[4]	-	M-E	N	Y	3	0	1	-
AGS 3015[5]	-	VE	Y	N	0	0	2	-

[1]Varieties highlighted in blue show data from 2021 yield trial as they were not included in 2022 trial
[2]AVG. Yield is a three year average
[3]All disease ratings are from a 2021 trial in Citra, FL. 0= Least Susceptible, 9= Most Susceptible. Those without a value were either not rated or the variety was not included in the 2021 disease trial
[4]Consider using a labeled fungicide; highly susceptible to powdery mildew, leaf rust, stripe rust, or crown rust
[5]Susceptible to some Hessian fly; consider using an insecticide.
[6]Consider using a labeled fungicide appropriate for Fusarium head blight.
[*]Variety to be dropped from list for 2023-24.

Table 3. Yield and Characteristics of recommended wheat varieties in the Coastal Plains Region of Georgia for the 2022-2023 growing season.

2022-2023 Coastal Plains Region Wheat Recommendations								
Variety[1]	AVG. Yield[2]	Maturity	Susceptible to Hessian Fly	Fungicide Recommended	Leaf Rust[3]	Powdery Mildew	Septoria Leaf Blotch	Fusarium Head Blight
Dyna-Gro Plantation	88.1	M-E	N	N	0	0	1	-
AM 481	87.8	VE	N	N	0	0	4	-
SH 9310	84.8	M	N	N	1	0	1	-
AGS 3026[5]	84.6	M-L	Y	N	-	-	-	-
USG 3752	83.2	M-L	N	N	-	-	-	-
AGS 2024[4]	82.7	M-E	N	Y	0	0	4	-
AGS 3040	82.3	M-L	N	N	-	-	-	-
AGS 4043	82.1	M-L	N	N	-	-	-	-
*USG 3640	82.0	M	N	N	0	0	4	-
Dyna-Gro Riverland	81.5	M-E	N	N	0	0	2	-
Johnson[4]	80.6	M	N	Y	5	0	3	-
AP 1983	80.4	-	N	N	-	-	-	-
AGS 3015[5]	80.1	VE	Y	N	0	0	2	-
SH 5550[6]	79.8	M	N	Y	0	0	1	-
AGS 2021	79.5	M	N	N	0	0	3	-
LW2026	79.5	-	N	N	0	0	2	-
Go Wheat 2032[4]	79.3	M-L	N	Y	0	0	6	-
*PGX 20-15	78.9	-	N	N	-	-	-	-
Dyna-Gro Blanton	78.5	M	N	N	0	0	4	-
*Pioneer 26R94	77.5	E	N	N	0	0	4	-
Dyna-Gro Rutledge	77.2	E	N	N	1	0	3	-
AGS 4023	75.1	M	N	N	-	-	-	-

[1]Varieties highlighted in blue show data from 2021 yield trial as they were not included in 2022 trial

[2]AVG. Yield is a three year average

[3]All disease ratings are from a 2021 trial in Citra, FL. 0= Least Susceptible, 9= Most Susceptible. Those without a value were either not rated or the variety was not included in the 2021 disease trial

[4]Consider using a labeled fungicide; highly susceptible to powdery mildew, leaf rust, stripe rust, or crown rust

[5]Susceptible to some Hessian fly; consider using an insecticide.

[6]Consider using a labeled fungicide appropriate for Fusarium head blight.

*Variety to be dropped from list for 2023-24.

Land Preparation, Seed Placement, and Traffic Patterns

Richard Roth

Land Preparation

In-field soil conditions at planting are key to optimal wheat production. Research across the Southeast has shown that deep tillage consistently increases wheat yields, especially in fields with hard pans or compacted soils. Dense compacted soils can lead to low soil-oxygen conditions, especially in wet years, causing poor root production and nutrient uptake and reduced grain yields. Tillage helps breakup compacted soils and optimize yield potential by allowing for better root growth increased water and nutrient uptake, and reduced surface residue which may host diseases and pests.

While the most reliable land preparation option for optimal wheat yields is deep tillage (bottom or paraplowing or V-ripping) chiseling is also an acceptable option especially when double-cropping field operations make deep tillage impractical. A quicker and potentially more economical option than deep tillage or chiseling is disking, which develops an excellent seedbed. However, repeated disking can lead to the formation of a hardpan due to the weight of the implement being concentrated in a very small area at the tip of the disk.

In South Georgia, no-till wheat production can reduce yield potential by 3-20% compared to tilled systems. However, despite potential reductions in wheat yield, no-till may be considered may be employed by growers to help reduce on-farm erosion and to save on tillage costs.

Seed Placement

Proper seed-placement helps ensure uniform emergence and optimum wheat grain yield potential. Consistent seed distribution, seed to soil contact, and seeding depth are all critical factors in attaining a successful wheat stand. Good seed to soil contact and adequate soil moisture allows for rapid emergence and root development. Uniform emergence is best achieved with uniform seed distribution and a consistent seeding depth of 1 to 1.5-inches. Uncontrolled planting methods, such as broadcast seeding, can result in poor wheat stands due to inconsistent seed distribution, seed to soil contact, and seeding depth. While broadcasting is still an option for planting wheat, research across the Southeast has shown that wheat planted with a properly calibrated grain drill produces yields that are consistently greater than wheat that is broadcast seeded.

Traffic Patterns

Establishing traffic row patterns, or tramlines, at planting or soon after emergence can be beneficial for all post-emergence field traffic. If all planting and post-emergence field equipment is the same size or divisible (i.e. 30-ft drill, 60-ft throw on fertilizer spreader, and 90-ft spray boom) then tramlines may be established at planting by closing off one or more row-units in the tire pattern. If the width of planting and post-emergence field equipment is not

equivalent then tramlines may be established shortly after emergence by desiccating with glyphosate using hooded drop nozzles.

Using tramlines in intensively managed wheat enables uniform application of nutrients and pesticides with improved precision and timeliness, especially when precision guidance technology is used to establish tramlines. When precision agriculture technology such as light bars and GPS auto-steer systems are used to establish tramlines the error associated with overlapping post-emergence fertilizer and pesticide applications is reduced. Tramlines can also save on the cost of aerial applications and reduce the chance of disease development. Plant injury, caused by running over standing wheat, provides entry points for many pathogens that will reduce grain yields or require fungicide applications to maintain grain yield. Studies have demonstrated that plants bordering the tramlines will compensate up to 50 – 60% of grain yield lost to tramlines; whereas, plants damaged by equipment traffic rarely produce good yields.

Planting Date

Richard Roth

Planting Date

Late planting dates based on "fly-free dates" are utilized in many parts of the country to avoid problems with Hessian fly, but in Georgia there are no "fly-free dates". Instead, average first frost date is used as the key indicator for recommending wheat planting windows in different regions of Georgia. Optimal wheat planting windows in Georgia are generally within one week before or after the average first frost date for a given region (Table 4).

Planting within the recommended timeframe allows for sufficient fall tiller production while avoiding excessive heat and moisture stress, and reduces the likelihood of needing two N applications in the spring. Fall tillers produce stronger root systems, are more stress tolerant, and have greater yield potential than spring tillers. In fact, research has show that fall tillers account for 85% of wheat yield potential. Late Planting can lead to poor tiller production prior to winter, resulting in the crop being more dependent on spring tillers which generally produce smaller grain heads with fewer spikelets and less yield potential.

Wheat requires approximately 100 tillers per square foot by GS 30 (stem elongation) to maximize yield potential, and timely planting provides the best opportunity to produce sufficient tillers by that timeframe. Crops with less than100 tillers per square foot at GS 25 (i.e. 50-60 per square foot) may need an additional N application in the early spring prior to the traditional topdress application to support additional tiller production (additional information in fertility section).

Table 4. General planting windows for most wheat varieties grown in Georgia by Region

Region	Planting Period
Mountain, Limestone Valley	October 10 – November 1
Piedmont	October 25 – November 15
Upper & Middle Coastal Plain	November 7 – December 1
Lower Coastal Plain	November 15 – December 1
Lower Coastal Plain**	December 1 – December 15

** Only varieties with short vernalization requirements

Vernalization Requirements

Timely planting is key to successful wheat production as planting too early or too late can limit wheat grain yield potential. Effective planting dates can be difficult to determine due to variation in vernalization requirements amongst wheat varieties. The vernalization process requires temperatures to fall below a certain temperature for a specific amount of time and for varieties grown in the Southeast this can be as short as one day or as long as six weeks.

Generally, the longest vernalization periods are required by late maturing varieties; thus, these should always be planted first as their vernalization can begin as soon as the seed absorbs water and begins to swell. Long vernalization periods may also be needed for medium maturing varieties, meaning these varieties may not be suitable for late plantings. In the absence of sufficient chilling hours, wheat will delay heading waits until nights are short and enough heat units have accumulated. Delays in heading can lead to grain fill occurring during hot, dry periods such as May or June, which can decrease grain weight and yield potential.

If late planting must occur, choose an early maturing variety as these require the shortest vernalization period. This helps ensure proper vernalization even in a mild or warm winter. To help prevent the possibility of winter kill or injury from late spring freezes which can occur if plants reach the jointing and heading stages too early, growers should avoid planting these varieties too early in the season.

Depending on maturity group the effect of late planting on yield potential can be severe. Table 5 demonstrates the effect of planting date on the yield potential of early, medium, and late maturing wheat varieties. These data demonstrate the effect of delayed planting on yield potential is much greater for late maturing varieties, which have the greatest vernalization and growing degree day requirements, than medium or early maturing varieties.

Table 5. Effect of Planting Date on Yield (bu/a) of Soft Red Winter Wheat in Tifton, GA

Planting Date	Early	Medium	Late
Nov. 23	76.8	78.6	76.5
Dec. 7	71.4	69.2	68.8
Dec. 20	54.2	47.1	25.3

Seeding Rate

Richard Roth

Seeding Rate

Planting as accurately as possible is the best way to maximize yield potential. Basing wheat seeding rates on seeds/acre rather than weight/acre has proven most accurate. However, differences in seed quality, genetics, and planting condition, date, and method (seed-drill vs. broadcast) can cause optimum seeding rates for wheat to vary widely.

Research across the Southeast has shown that the optimal wheat seeding rate is 1.2 million to 1.5 million seeds/acre, which equates to approximately 30-35 seeds/square foot. Knowledge of seed size (number of seeds per pound) is key to achieving this rate. Generally, seed size of common wheat cultivars varies between 10,000 and 18,000 seeds/pound.

As seen in Table 6, there can be high variability in seeds/pound amongst different wheat varieties, which can impact actual seeding rate and lead to over-planting or under-planting by growers who seed based on pounds/acre. This illustrates the importance of purchasing wheat seed based on seed size with a target of 30-35 seeds/square foot, rather than a set weight/acre.

Table 6. Example of seeds/pound of wheat grown in one year in Georgia

Variety	**Seed/Pound**
1	9,610
2	11,340
3	14,823
4	12,064
5	11,172
6	16,316
7	12,741
8	14,538
9	15,534
Average # Seeds/Pound	**13,126**

In general, planting 20-25 seeds per row foot is adequate to achieve optimum yield potential and the target number of 30-35 seeds/square foot. Table 7 presents the appropriate seeds per row foot for various row widths to achieve desired planted seed densities. Seeding rates should be increased by 15-20% if planting is delayed.

Table 7. Seeds/linear row foot needed to achieve certain seeds/square foot at different row widths.

	Seed/square foot			
Row Width in.	**30**	**35**	**40**	**45**
6	15	18	20	23
7	18	20	23	26
7.5	19	22	25	28
8	20	23	27	30
10	25	29	33	38

Table 8 demonstrates the effect of seed size, row spacing, and seeds per row foot on the weight of seed needed per acre to achieve the same population. In this example, a grower would need to purchase 128 pounds of seed/acre if their chosen variety had 12,000 seeds/pound and is planted in 7.5-inch rows at 22 seeds/row foot. By comparison the grower would only need to purchase 102 pounds/acre to achieve the same target population if the variety had 15,000 seeds/pound. This illustrates the importance of understanding seed size when purchasing wheat varieties.

Table 8. Example of pounds of seed/acre as determined by row width, seeding rate, and seeds/pound.

	Row Width					
	6-inches		**7.5-inches**		**10-inches**	
Seed/row ft.	12,000	15,000	12,000	15,000	12,000	15,000
18	130.7	104.5	104.5	83.6	78.4	62.7
22	159.7	127.8	127.7	102.2	95.8	76.7
26	188.8	151.0	151.0	120.8	113.3	90.6
30	217.8	174.2	174.2	139.4	130.7	104.5

Seed Selection

When choosing wheat seed growers must decide between certified seed or bin-run (seed saved from previous years crop) seed. It is strongly recommended that growers utilize certified seed as it comes from a known source and is guaranteed to have at least an 85% germination rate and to be free of noxious weeds. Bin-run seed is generally not recommended unless the wheat is being used as a cover crop or forage. Bin-run seed can be of poor quality and contain noxious

weed seeds, leading to poor stand establishment and contamination. If growers do use bin-run seed it should be thoroughly cleaned (eliminates non-viable seed and noxious weeds) and the germination rate verified prior to planting.

Grain Drill Calibration

In order to ensure consistent seeding rates and yield potential, it is recommended that grain drills be calibrated any time you change variety or seed lot. Growers should contact their county agents for help calibrating grain drills, or they can use the procedure outlined below.

Grain drill calibration can be completed using the following steps:

1. Measure a known distance that you can calibrate to an acre.
2. Remove the rubber tubes that lead to the disk openers.
3. Use plastic bags, cups, bottles, etc. to catch seed from individual drop tubes as you travel the known distance.
4. Determine the seeds per acre being planted using one of the following methods:
    a. If calibrating for seeds per row foot, count the number of seeds from one row unit and divide by the number of feet traveled to obtain the number of seeds per row foot. Do this for multiple row units to ensure consistency.
    b. If calibrating for seeds seed weight per acre, Weigh the seed from all row units and then convert this value to pounds/acre using the total planting width and distance traveled.
5. If necessary, adjust the settings on your grain drill and repeat steps 3 and 4 until the desired seeding rate is obtained.

Further information on grain drill calibration can be found at:

https://extension.uga.edu/publications/detail.html?number=B1510

Harvest Timing and Grain Quality

Richard Roth

Timely wheat harvest is key to producing a marketable wheat crop. However, a common challenge amongst Georgia wheat growers is harvesting a crop with marketable grain quality. Combines are often kept out fields beyond grain maturity due to heavy spring rains, which can lead to pre-harvest sprouting of the grain in the head. This can result in decreases in grain quality as the crop waits to be harvested. Weak markets and grain quality standards at buying points are key challenges to profitable management, production, and sale of wheat amongst Georgia growers. Marketability of wheat is often influenced by falling number, which is an industry standard for grain quality used by wheat buyers. However, this quality parameter most commonly misunderstood by growers.

The falling number test is used to assess sprout damage, which can lead to reduced grain quality. Over the years, the test has consistently proven itself as an accurate indicator of wheat starch composition. The test indirectly measures alpha amylase activity in a grain sample. Alpha amylase is an enzyme (biological rate controller) which increases as seed germination occurs and leads to the break down of starch to more usable forms for plant growth. Simply put, pre-harvest sprouting can lead to diminished grain starch which results in poor baking quality and shelf-life of the wheat flour.

The common falling number threshold used by wheat buyers is 300. Wheat with a value above 300 indicates good baking quality and shelf life while wheat with a value below 300 may be considered or poor quality. To calculate falling number, a flour and water slurry is made and then a viscometer is used to measure the viscosity (or thickness) of the slurry. A thinner slurry results in a lower falling number which indicates low starch content, which leads to poor baking quality and shelf-life of the wheat flour.

Straw Utilization

Richard Roth, Henry Sintim, and Glen Harris

The utilization of wheat straw has the potential to provide added economic value to wheat production systems. Though there are many potential methods of utilizing wheat straw, the most popular include as residue in conservation tillage systems, for reducing soil erosion during construction, as horse bedding, and for hay feeding. Generally, greater grain yield means greater straw production; however, this varies by variety and even year to year within variety. Removing straw from the field also removes additional nutrients from the field and it is critical that these nutrients be accounted for when fertilizing the field for the subsequent crops. On average, 39%, 19%, and 83%, respectively, for N, P, and K taken up by wheat is partitioned into the straw. For a 70 bu/ac yield of wheat, approximately, 50, 9, and 118 lb/ac for N, P, and K, respectively, is accumulated in the straw.

Fertility Recommendations

Glen Harris and Henry Sintim

Soil fertility is one of the primary yield building components of small grain management. A properly managed fertility program, including recommended fertilization and liming practices, can improve yield and quality more than any other single management practice. Such a program includes soil testing, knowledge of crop nutrient requirements and removal, timely application of nutrients and record-keeping.

Nutrient Uptake and removal

Nutrient uptake and removal varies with yield (Table 9). Most fertilizer recommendations account only for nutrients removed in the grain. When straw is also removed, additions of phosphorus (P), potassium (K), and sulfur (S) should be increased for the following crop.

Table 9. Nutrient uptake (in lbs/a) of wheat grain and straw at different yield levels.

	Yield (bu/a)								
	40			70			100		
	Uptake	Removal		Uptake	Removal		Uptake	Removal	
Nutrient		**Grain**	**Stover**		**Grain**	**Stover**		**Grain**	**Stover**
			---------------------------------- pounds per acre ---------------------------------------						
N	75	46	29	130	80	50	188	115	73
P_2O_5	27	22	5	47	38	9	68	55	13
K_2O	81	14	14	142	24	118	203	34	169
Mg	12	NA	NA	21	NA	NA	30	NA	NA
S	10	NA	NA	18	NA	NA	25	NA	NA

Nitrogen (N)

Nitrogen rates and timing of application are key management factors for making good wheat yields and minimizing the sensitivity of wheat to frost injury. Nitrogen rates should be based on soil potential, cultivar, realistic yield goal, previous crop and residual N. For expected wheat yields of 40 to 70 bushels per acre, use a total N rate of 80 to 100 pounds per acre. Higher yields will likely require rates of 100 to 130 lbs per acre or more.

Applying nitrogen in the fall is critical to encourage good tiller production prior to the onset of winter. Adjust this rate based on the preceding crop. Fall nitrogen application rates based on previous crop can be seen in Table 10.

Table 10. Fall nitrogen application rates for wheat based on previous crop

Previous Crop	Fall N Rate (lbs/A)
Fallow	25 – 30
Peanut	0 – 15
Soybean	15 – 20
Corn	30 – 35
Cotton	35 – 40

Tillers produced in the fall generally produce the most grain per unit area. It is important though, not to over-fertilize with nitrogen in the fall as it may cause excessive growth and result in winter injury.

Timing of N fertilization should be based on the pattern of uptake by the crop. Demand for N is relatively low in the fall but increases rapidly in the spring just prior to stem elongation. Therefore, make the fall applications of nitrogen at planting, and the remaining N prior to stem elongation (Zadoks 30). Use the lower rate of fall applied nitrogen at planting on heavier textured soils and the higher rate on sandy soils.

When the wheat crop reaches the growth stage Zadoks GS 25, begin counting tillers to determine the need for additional nitrogen applications for the proper tiller production prior to the onset of stem elongation. This stage of growth generally occurs during the mid to later week of January in south GA and late January to mid-February in north GA. Randomly chose about 10 to 15 areas in the field to obtain an accurate estimate of tillers per square foot. Figure 1 can be used to get a nitrogen rate recommendation after counting the tillers. If the tiller counts (a stem with at least three leaves) are low, 80 tillers per square foot or less, nitrogen applications at this time are critical for improving the yield potential of the crop. Some nitrogen will still be needed to maximize the yield potential if the tiller counts are lower than 100. If the tiller count exceeds 100 or more per square foot at Zadoks GS 25, then apply all remaining nitrogen at or just before GS 30 (stem elongation). Usually Zadoks GS 30 (or Feekes 5) occurs during early to mid-February in the southern half of Georgia. In extreme north GA, stem elongation may not occur till early March.

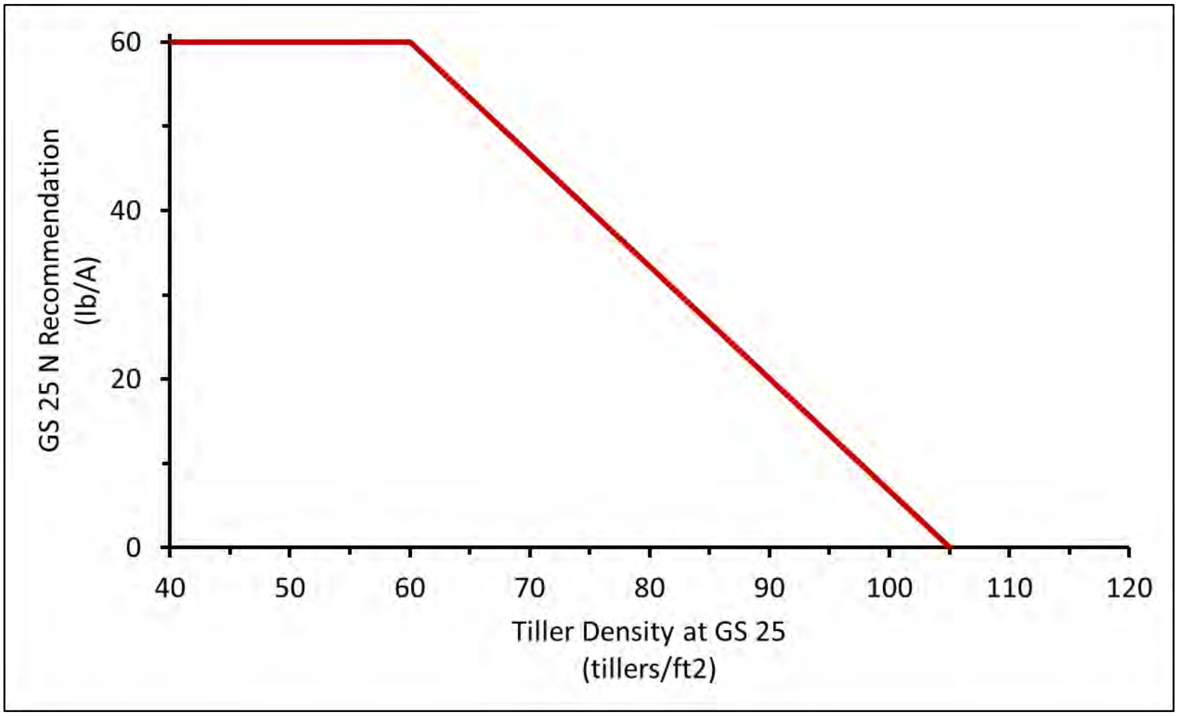

Figure 1. Wheat GS25 nitrogen recommendation (lbs/ac) based on GS25 tiller density.

Splitting spring nitrogen applications can improve yields when N leaching conditions occur. Although yields may not always be improved, this practice can also reduce the amount of N released into the environment, and offers the chance to adjust N rates downward if climatic or economic conditions do not warrant the added expense of the last N application.

Figure 2 is a guide used by growers in North Carolina and Virginia to determine the need for nitrogen at GS 30 (or Feekes 5). It assumes that the average tiller count will be above 100 per square foot. GS 30 is when the leaf sheaths of the wheat plant are strongly erected and splitting the stem shows a hollow internode area about 1/4 to 1/2 inch in length. It is important to have an accurate assessment of the nitrogen content at the right growth stage prior to completing the final N applications. Obtain a representative tissue sample from about 20 areas in the field. Cut the samples about ½ inch above the soil surface making sure to shake any dirt away from the tissue. Pick away any debris or dead leaves from the sample. Combine the samples and mix thoroughly. Take two to three handfuls out of the combined sample for testing and place in a paper bag. Send the sample immediately to an appropriate lab.

Use the graph below to obtain the rate recommendation from tissue test results taken just prior to the onset of stem elongation. Total N applications generally should not exceed 130 lbs N per acre. Make the final N adjustments based on these results.

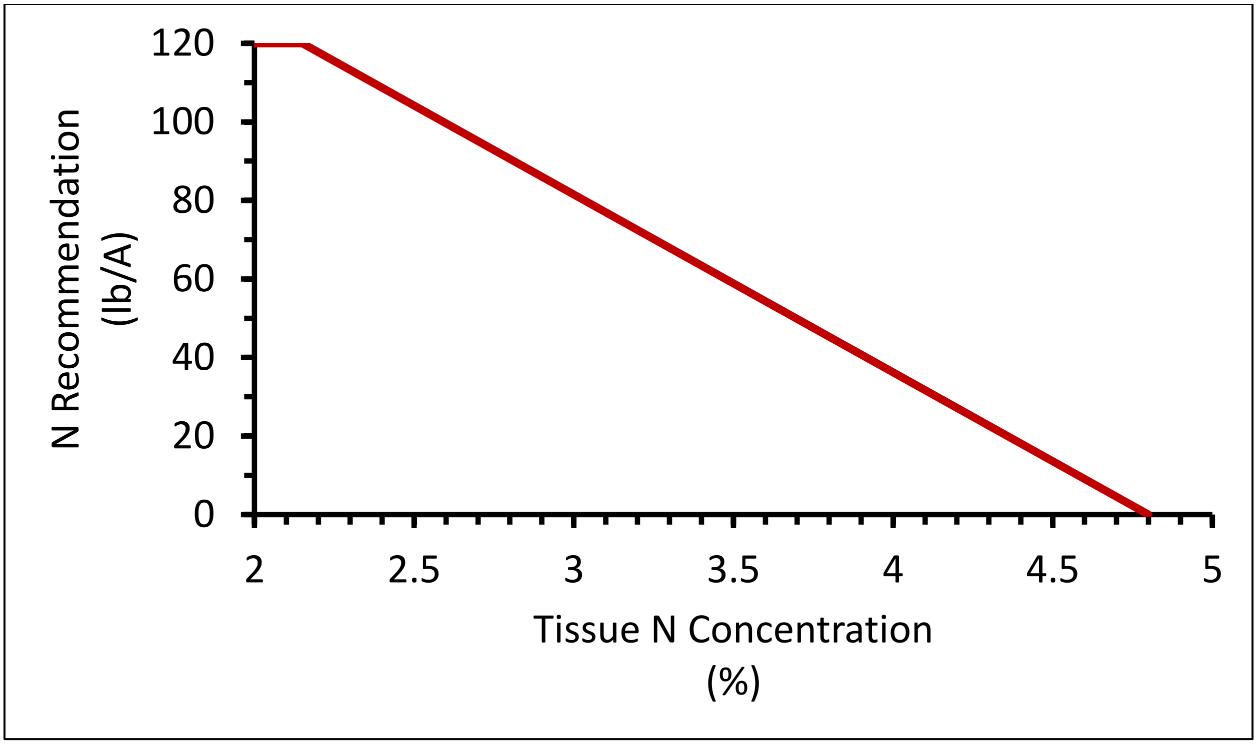

Figure 2. Wheat GS30 nitrogen recommendation based on tissue nitrogen concentration obtained from a reputable lab.

For example, let's say the tissue analysis results show a 3.0% N content at GS 30 but you applied 20 lbs N at planting and 40 lbs N at GS 25. If the graph calls for 80 lbs then only apply 70 of the 80 lbs of N the graph suggests since it would exceed the upper limit of 130 lbs N in the season (20 + 40 = 60; 60 + 70 = 130).

Nitrogen fertilizer prices have increased significantly over the last five years but declined slightly this fall as compared to last year. Therefore, choosing the proper rate and timing of application is critical in terms of making an economic yield. Also, there are still a good number of different nitrogen fertilizers to choose from that vary in characteristics and price. Be careful not to choose a nitrogen fertilizer based on price alone. In addition, there is currently a shift away from ammonium nitrate to urea. Urea volatilization is of greater concern under hot and dry conditions. The timing of N applications on wheat are typically not that conducive to losing large amounts of N from urea. Irrigation or rainfall can also reduce N losses from volatilization of urea. Urease inhibitors such as Agrotain are commercially available and when added to urea can reduce volatilization losses, especially in dryland conditions.

Phosphorus (P) and Potassium (K)

Since 65% of the total P uptake and 90% of the total K uptake occurs before the boot stage, these nutrients should be applied according to soil test before planting and thoroughly incorporated into the rooting zone. When double cropping after wheat, apply P and K for fall

and spring crops prior to fall planting, except on deep sands. In this case, split K applications between the fall and spring crops.

Sulfur

Sulfur (S) leaches readily in sandy soil horizons, but accumulates in subsoil clay horizons. If the depth to clay is greater than 16 inches, apply at least 10 pounds of S per acre. Best results are obtained when S is supplied with topdress N applications.

Micronutrients

Micronutrient levels in Georgia's soils are usually adequate for wheat production unless soils have been over-limed. Low zinc (Zn) levels may occur in soils of the Coastal Plain. A soil test readily detects these conditions, and it is easily corrected by applications of three pounds of elemental Zn per acre in the preplant fertilizer. Manganese (Mn) deficiency occurs most frequently in poorly drained soils of the Flatwoods region. Availability of Mn declines significantly as pH increases above 6.2 to 6.5 in these soils. Soil applications seldom correct the problem since Mn is readily converted to unavailable forms. Foliar applications of 0.5 pounds of Mn per acre as $MnSO_4$ or 0.25 pounds of Mn per acre as Mn chelate will correct deficiencies, but two or more applications may be required.

Poultry Litter

Managed properly, poultry litter (manure mixed with bedding material) can be a valuable source of plant nutrients for wheat production. It is most like a complete fertilizer, containing significant amounts of primary, secondary and micronutrients except for boron. On average, broiler litter contains approximately 3% N, 3% P_2O_5 and 2% K_2O (fertilizer value of 3-3-2). Based on this average, one ton of poultry litter contains 60 lbs of N, 60 lbs of P_2O_5, and 40 lbs of K_2O. On average, 60% N, 80% P, and 80% K of the nutrients in the poultry litter should be available in the first year.

Based on DTN fertilizer prices for the week of October 10-14, 2022, the unit price of N is \$0.97/pounds (urea price). The unit price of P_2O_5 is \$0.68/pounds (average price of DAP and MAP) and that of K_2O is \$0.70/pounds (potash price). Assuming the percent availability of the N, P, and K of poultry litter in the first year and their unit fertilizer prices, poultry litter can be valued at \$90/ton. Note that the nutrient content of litter does vary significantly, depending on moisture content, type of bird, feed ration and especially storage and handling methods. Therefore, it is highly recommended that litter be analyzed for nutrients by a reputable laboratory before determining application rates and value.

Application rates of poultry litter for fertilizer are usually based on the nitrogen requirement for the crop grown. Buildup of phosphorus however is an increasing concern due to water quality issues. Therefore, poultry litter is best used as a preplant incorporated, complete fertilizer to supply P, K, secondary and micronutrients to the crop on a timely basis. For wheat, an application of 2 ton/a of poultry litter (preplant incorporated) will supply an adequate amount of fall N and should meet the P and K requirements of even a soil testing low in P and K. The

remainder of the N requirement should then be applied in the spring using inorganic/commercial N fertilizer. Release of N from litter in the spring will depend on a number of factors, especially weather conditions. Therefore, the crop should be monitored in the spring; and topdress applications of inorganic, commercial fertilizer N should be adjusted accordingly.

You can access UGFERTEX (https://aesl.ces.uga.edu/calculators/ugfertex/), an online UGA system for formulating prescription lime and nutrient guidelines for agronomic crops. Note that the recommendations are based on Mehlich 1 extraction method and should therefore not be used for soil analyses with a different extraction method.

Weed Control in Wheat

Stanley Culpepper

Overview

Effective weed management is one of many critical components of successful wheat production. Weeds compete with wheat for light, nutrients, water, and space while often harboring deleterious insects and diseases. Severe weed infestations can essentially eliminate wheat production and/or harvest efficiency while also creating weedy plant fragments, often reducing food and feed value.

Winter annual broadleaf weeds such as wild radish, chickweed, and henbit; perennials such as wild garlic and curly dock; and annual ryegrass are often the most problematic weeds in wheat. Although each of these pests can be problematic, it is ryegrass that poses the greatest threat to the production of wheat and other grains in Georgia. Ryegrass populations have been confirmed to be resistant to all currently labeled effective postemergence herbicides. Growers must implement management programs to delay the development and spread of resistant ryegrass.

Cultural Control Methods

One of the most effective methods for suppressing weeds in wheat is a healthy, vigorous crop. Sound crop management practices that result in rapid wheat stand establishment and canopy development minimize the effects of weeds. Recommended cultural practices may include the following:

1) Planting certified seed (free of weed seeds and garlic bulblets)
2) Good seedbed preparation – free of weeds, clods, and plant debris
3) Proper fertilization
4) Seeding at the proper rate, planting depth, and time of year
5) Timely management of diseases and insects
6) Timely harvest and cleaning of combine when leaving problematic fields
7) Crop rotation

Site selection can determine one's potential success. Growers are strongly encouraged to avoid fields heavily infested with herbicide-resistant ryegrass; rotate these fields into cropping systems that allow other effective herbicide chemistries for at least three years. Additionally, so as to prevent weed spread from field to field during harvest, equipment should be cleaned when moving from infested areas. This precaution can be of significant consequence in preventing or minimizing the introduction of 'new' weed species into 'clean areas'.

Planning a Herbicide Program

Before using herbicides, growers should know what weeds are present or expected to appear,

soil characteristics (such as texture and organic matter content), capabilities and limitations including potential herbicide carryover, how best to apply each herbicide, and having an in-depth understanding of when to apply each herbicide relative to crop and weed stage of growth.

Weed Mapping

The first step in a weed management program is to identify the problem; this task is best accomplished by weed mapping. Surveys should be developed each spring to provide a written record of the species present and their population levels; plants surviving through the winter and producing seeds in the spring will likely be the most popular weeds the following season. Knowing which weed species will appear allows one to develop a more effective management program.

Before-season and In-season Monitoring

As with all crops, there should be no weeds present when planting. Remove all weeds at least 10 days before planting with herbicides or tillage. Additionally, scout fields a few days prior to planting and control any plants that survived previous control tactics as well as any newly emerging weeds. Once the crop is planted, fields should be monitored periodically to identify the need for postemergence herbicides. Even after herbicides are applied, monitoring should be continued to evaluate the success of the weed management program, to determine the need for additional control tactics, and to determine if there is a potential herbicide resistance issue. Identifying resistance early can be essential to long-term use of a given field. Proper weed identification is necessary to ensure effective control since weed species respond differently to various herbicides. Contact your local Extension office for aid in weed identification if necessary.

Managing Weeds with Herbicides

If applying herbicides, read and follow all label recommendations. Information concerning weed response to herbicides, herbicide rates, and grazing restrictions for wheat are in Tables 14-16.

Larger weeds are usually more difficult to control than smaller weeds; therefore, timely herbicide applications are critical. Many herbicides used in wheat affect growth processes within the weed. In essence, the more actively the plant is growing, the better the control. Applications made to stressed weeds (i.e. drought, wet, cold) will often result in decreased control.

All wheat herbicide applications are restricted to certain growth stages to minimize crop injury and to ensure illegal pesticide residues are avoided (Tables 11 and 12). Although the stage of development provides a good indicator for application timing, factors such as environmental conditions, health of the crop, and variety (early vs. late maturity) also impact crop tolerance.

Table 11. Wheat herbicides and their application window

Herbicide	Application Window in Wheat
2,4-D	Fully tillered but before jointing only
Axial Bold	Emergence through pre-boot
Axiom	After spike through 2 leaf
Express	After 2nd leaf and before flag leaf visible
Fierce	After spike through 2 leaf
Harmony Extra	After 2nd leaf and before flag leaf visible
MCPA	after tillering but before jointing
Osprey	Emergence through jointing
Powerflex	3rd leaf through jointing
Prowl H20	After 1st leaf and before flag leaf visible
Quelex	Preplant through just before emergence AND 2-leaf through flag leaf
Zidua	Delayed PRE through 4 tiller

Table 12. The effect of Stage of Growth on Wheat Injury by Various POST Herbicides.

Percent Injury by Stage of Wheat Growth[1]					
Herbicide	Pre-plant	0-1 tiller	2 tillers	full tiller	Jointing
2,4-D	>40%	>40%	15-40%	0-10%	>50%
MCPA	>25%	>25%	0-10%	0-10%	>35%
Harmony Extra	0-5%	0-10%	0-10%	0-10%	0-5%
Harmony + MCPA	>25%	>25%	5-15%	5-10%	>35%
Harmony + 2,4-D	>40%	>40%	15-40%	5-10%	>50%
Quelex	0-10%	0-10%	0-10%	0-10%	unknown
Osprey	unknown	0-15%	0-15%	0-15%	0-15%
PowerFlex	unknown	0-15%	0-15%	0-15%	0-15%

[1] Percent injury (visual chlorosis, necrosis, tiller malformation, and/or stunting).

Herbicides for Controlling Broadleaf Weeds

2,4-D

2,4-D controls many common winter broadleaf weeds such as buttercups, cornflower, cutleaf evening primrose, and wild radish (Table 14). However, 2,4-D often does not adequately control chickweed and henbit; thus, *mixtures with Harmony Extra should be considered*.

This auxin herbicide is available in several formulations (amines, esters, and acid + ester mixtures). Amine formulations are MUCH safer to use when sensitive plants are nearby; ***Georgia research has shown nearly 90% less impact from volatility/drift of an amine formulation of 2,4-D when compared to an ester formulation during hot weather.*** Amine formulations also tend to cause less burn on the wheat than esters when nitrogen is used as the carrier. When mixing an amine formulations with liquid nitrogen the herbicide often must first be premixed with water (one part herbicide to four parts water) and then the water-herbicide mixture added to the nitrogen with good agitation. Ester or acid + ester formulations tend to be more effective under very cold conditions as compared to amine formulations; rarely are differences noted among formulations in Georgia. Additionally, ester and acid + ester formulations mix well with liquid nitrogen.

Timing of application of 2,4-D is critical to avoid injury to wheat. The critical period for 2,4-D applications is after wheat is fully tillered but before jointing. Applications too early will likely cause a “rat-tail” effect whereby the leaf does not form and unfurl properly while the injured plant turns a very dark color. The crop may be stunted with a delay in maturity, and tiller development may be adversely affected with a subsequent yield loss observed. Conversely, application after jointing (too late) may result in malformed seed heads and yield loss.

Dicamba

Dicamba, an auxin herbicide, is labeled for use in wheat. It can be applied early-season as long as the application is complete prior to wheat jointing. Although dicamba has become an effective tool in agronomic crops, its value in wheat is much less because of the limited maximum use rate of 0.12 lb ai/A (ie Clarity = 4 oz/A). This rate of dicamba is extremely low and of little value except in rare situations; little to no control of radish is observed.

MCPA

MCPA, an auxin herbicide, controls a broad spectrum of broadleaf weeds similar to those noted with 2,4-D (Table 14). When compared to 2,4-D, MCPA is generally less injurious to wheat but also a little less effective on larger weed species. MCPA should be applied after wheat begins tillering (preferably 2+ tillers) at a rate of 12 to 16 oz/A (4.0 lb ai material) up to just before jointing; if wheat is fully tillered the rate can be increased to 19 oz/A (4 lb ai material).

MCPA plus Harmony Extra offers weed control similar to 2,4-D plus Harmony Extra with less crop injury potential.

Harmony Extra

Harmony Extra is a prepackaged mixture of the sulfonylurea herbicides thifensulfuron-methyl and tribenuron-methyl and can be applied in wheat after the two-leaf stage but before the flag leaf is visible. Applications should be completed by the fully tillered stage for improved spray coverage on weeds.

Harmony Extra controls many of the common winter annual broadleaf weeds including wild garlic and curly dock (Table 14). However, cornflower and wild radish are exceptions while henbit can be challenging to control depending on its physiological maturity. MCPA or 2,4-D at 0.375 to 0.5 lb ai/A may be mixed with Harmony Extra for excellent wild radish control and improved control of cornflower; mixtures must follow the growth stage restrictions noted with 2,4-D or MCPA.

A nonionic surfactant at the rate of 1 quart per 100 gallons of spray solution is recommended when Harmony Extra is applied in water. Harmony Extra also may be applied using liquid nitrogen as the carrier. In this case, premix the herbicide in water and add the mixture to the nitrogen with agitation. Adding surfactant when using nitrogen as a carrier will increase burn on the wheat foliage. Thus, when applying Harmony Extra in nitrogen, reduce the surfactant rate to 0.5 to 1.0 pint per 100 gallons of spray solution. For easy-to-control weeds, consider eliminating the surfactant when nitrogen is the carrier. However, do not eliminate surfactant when treating wild garlic or wild radish. Do not use surfactant when mixtures of Harmony Extra plus 2,4-D or MCPA are applied in nitrogen.

An advantage of Harmony Extra compared to 2,4-D or MCPA is the wide window of application; however, tank mixtures of these herbicides are suggested for wheat in the appropriate growth stage.

Express

Express (tribenuron) is a sulfonylurea herbicide and can be effective on many winter annual broadleaf weeds if mixed with 2,4-D or MCPA (Table 14). Express alone can be applied after the wheat has two leaves but before the flag leaf is visible; if mixing with 2,4-D or MCPA follow their respective growth application restrictions. Express may be slurried with water and then added to liquid nitrogen solutions. Use 1.0 pt of surfactant per 100 gallons of spray solution when applying Express in water; use 0.5 pt of surfactant per 100 gallons when mixing with nitrogen, 2,4-D or MCPA; use 0.5 pt of surfactant per 100 gallons when mixing with nitrogen plus 2,4-D or MCPA.

Quelex

Quelex (halauxifen-methyl + florasulam) is a mixture of an auxin herbicide and a sulfonylurea herbicide. The label allows it to be used as a preplant burndown treatment to wheat to control emerged weeds prior to, or shortly after planting (prior to emergence). It may also be used as a postemergence tool when wheat is between 2 leaf and flag leaf. Do not apply more than 0.75 oz/A per growing season and no more than 2.25 oz/A per year for burndown and in-season use.

The label claims control of common chickweed, Carolina geranium, henbit, horseweed, wild mustard, and volunteer soybean when the weeds are less than 4 inches tall; although the herbicide is still new for wheat growers, UGA research to date supports these findings.

A non-ionic surfactant at 0.2 to 0.5% v/v or a crop oil concentrate at 0.5 to 1% v/v should be included with Quelex (UGA research has focused on 1% v/v of crop oil concentrate). It may be applied in spray solutions containing liquid nitrogen fertilizer but, in this case, use only the non-ionic surfactant.

Tank mixtures with other labeled herbicides can be made with a few restrictions: 1) cannot mix with glufosinate, 2) must read labels of products mixed, and 3) must perform a jar test to ensure compatibility.

Wild Radish Control

Wild radish can be controlled effectively with numerous herbicide options if they are applied timely (Table 13). Harmony Extra + MCPA or 2,4-D is an excellent option to control wild radish as well as most other commonly present broadleaf weeds. PowerFlex and Osprey, effective ryegrass herbicides, are also very good options for controlling wild radish.

Table 13. The effect of Stage of Growth on Wild Radish Control in Wheat.

	Percent Control By Leaf Rosette Diameter and Maturity			
Herbicide	0-4 inches	4-8 inches	8-12 inches	Bolting/Flowering
2,4-D	>99%	>95%	>90%	80-90%
Dicamba	<50%	<40%	<20%	<20%
MCPA	>99%	>95%	>80%	70-80%
Express	60-90%	50-70%	40-50%	<35%
Harmony Extra	70-90%	60-80%	40-70%	<50%
Express + MCPA or 2,4-D	>99%	>99%	>90%	70-85%
Harmony + MCPA or 2,4-D	>99%	>99%	>95%	80-95%
Quelex	>99%	80-95%	50-75%	<60%
Osprey	>99%	90-95%	60-75%	40-65%
PowerFlex	>99%	>95%	>85%	75-90%

Wild Garlic Control

Wild garlic is virtually noncompetitive with small grains. However, the aerial bulblets harvested with the grain impart a garlic flavor to flour made from infested wheat. Off-flavor milk products result when dairy cows are fed infested small grains; growers may receive a substantial discount.

Harmony Extra with TotalSol (50 SG) at 0.75 to 0.9 oz/A is very effective; be sure to add non-ionic surfactant as noted above. Wild garlic should be less than 12 inches tall and should have 2 to 4 inches of new growth (if treated in the spring) when Harmony Extra is applied. Temperatures of 50^0 F or higher will enhance control.

There are no rotational restrictions following wheat treated with Harmony Extra.

Cultural and Mechanical Control of Italian or Annual Ryegrass

Georgia wheat production is challenged mightily by herbicide resistant ryegrass. Ryegrass resistant to all currently labeled postemergence herbicides has been confirmed and is spreading. Growers must implement management programs to delay the development and spread of resistant ryegrass.

Research has shown that wheat yields can be reduced 0.4% for every ryegrass plant per square yard. Heavy infestations, if uncontrolled, can eliminate production. Italian and annual ryegrasses are annuals with spread through seed production. Management practices to reduce seed production and spread will greatly decrease ryegrass problems. Such practices may include the following: cleaning equipment from field to field, maintaining clean fence rows and ditch banks surrounding the fields, rotating fields with heavy ryegrass populations into other crops allowing alternative control methods, and avoiding saving and then planting seed harvested from fields infested with ryegrass the previous season.

Additionally, research has confirmed deep turning can have a significant influence on the emergence of annual ryegrass. Figures 3 and 4 below note how effective deep turning may be in reducing ryegrass emergence. By spring in this experiment, ryegrass emergence was reduced over 99% with deep turning. Although this experiment does not address ryegrass seed spread throughout the soil profile which is present in grower fields, it does suggest ryegrass seed do not emerge very well when placed deep in the soil profile. The next step is to better understand how long the seed will live buried in our soils and our environment.

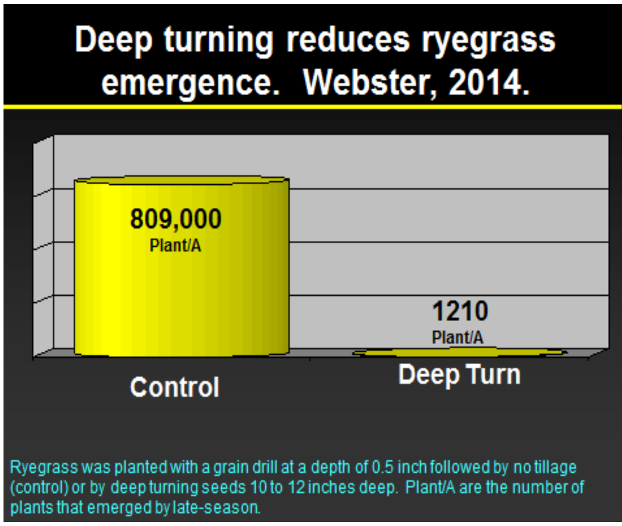

Figure 3. The effect of deep turning on ryegrass emergence.

Figure 4. A photo illustrating the effect of deep turning on ryegrass emergence.

Rarely will any cultural or mechanical practice effectively control ryegrass by itself. Thus, an herbicide program will usually be needed.

Herbicides for Controlling Italian or Annual Ryegrass

Axial Bold, active ingredients pinoxaden and fenoxaprop-p-ethyl, at 15 fl oz/A can be applied postemergence to wheat between emergence and the pre-boot stage. Axial Bold has replaced Axial XL. Ryegrass resistant to Axial is present in Georgia and will not be controlled with Axial Bold. For populations not resistant, apply in 10 gallons of water per acre. Rain falling after 30 minutes of application will not impact control. Axial can be applied only once per crop and will not offer residual control or control of broadleaf weeds.

Only one application of Axial bold per year.

Mixtures with Quelex are approved on the label as well as numerous other products but currently Harmony Extra alone is not listed.

The Axial Bold label does allow it to mixed in a spray solution containing up to 50% liquid nitrogen fertilizer; add Axial to water first and after mixing thoroughly add fertilizer. *Consider not mixing Axial with nitrogen fertilizer because of the potential for reduced ryegrass control (antagonism).*

Any crop can be planted after 90 days.

Axiom, active ingredients flufenacet and metribuzin, can be applied to wheat after the spike stage of growth up to the 2-leaf stage. Preemergence applications can cause severe crop injury, especially on sandier soils when conditions are wet during crop emergence. Injury has also been observed occasionally when Axiom is applied during the spike stage of growth if heavy rains or recurring rainfalls/irrigation occur within a few days of application.

If Axiom is activated prior to ryegrass emergence then control will be good, but if ryegrass emerges prior to Axiom being activated then control will be poor. Axiom will also provide fair to good control of several problematic broadleaf weeds, including wild radish and henbit. Axiom may be used as part of an herbicide resistance management program because it has an alternate mode of action for the control of ryegrass compared to typically used products such as Axial, Osprey, and PowerFlex. Those wanting to use Axiom need to review the label very carefully regarding injury potential and use rates. Most Georgia growers will be using 6 oz of product/A (or less in some environments), but, again this should be determined from your soil type, label restrictions, and expected rainfall/irrigation the week following application.

Onions and sugar beets can be planted 18 months after applying Axiom; cotton 8 months; and potato 1 month. No plant back issues exist for corn or soybean. See label for other crops.

Fierce, containing the active ingredients flumioxazin plus pyroxasulfone, has obtained a Section 24 (c) Special Local Need label for Georgia wheat. Wheat must be planted between 1 and 1.5 inches deep; Fierce cannot be applied to wheat that has been broadcast and shallow incorporated. Fierce should be mixed only with water and can be applied topically once 95% of the wheat is in the spike to 2-leaf stage of growth. ***Rainfall or irrigation of ½" must occur prior to ryegrass or radish reaching ½ inch in height for effective control.***

DO NOT apply Fierce to heavy sands or low organic matter soils as injury is expected with significant rainfall or irrigation that occurs soon after application.

The rate of Fierce depends on which formulation is being used. Currently the dry formulation of Fierce is labeled and should be applied at 1.5 oz/A; however, the liquid formulation of Fierce EZ at the use rate of 3 fl oz/A is expected to replace the current formulation during the 2022-2023 season.

Osprey, active ingredient mesosulfuron-methyl, is a postemergent herbicide applied at 4.75 oz per acre in wheat from emergence up to the jointing stage to control ryegrass with less than 2-tillers. If applied properly and timely, Osprey controls ryegrass well as long as it is not ALS-resistant. Osprey is a sulfonylurea-type herbicide and works slowly. Symptoms appear three to four weeks after application but eight weeks may pass before ryegrass dies. Four-hour rain fastness required.

An adjuvant is required. The manufacturer is currently recommending a nonionic surfactant containing at least 80% surface-active agents (0.5% by volume; 2 quarts per 100 gallons spray solution) plus 1 to 2 quarts per acre of urea ammonium nitrogen fertilizer (28-0-0, 30-0-0, or 32-0-0) or ammonium sulfate fertilizer at 1.5 to 3 pounds per acre (21-0-0-24).

Apply Osprey in 12 to 15 gallons of water per acre; do not use liquid nitrogen as a carrier; and do NOT apply Osprey within 14 days of topdressing. Occasionally, significant injury has been observed when wheat has been top-dressed shortly after an Osprey application. Separate Osprey and 2,4-D or MCPA applications by at least 5 days.

Osprey may be mixed with Harmony Extra to improve control of broadleaf weeds. The label also allows a mixture with MCPA; however, antagonism (reduced ryegrass control) with Osprey/MCPA mixtures has been noted in several Georgia research studies. Osprey will also provide good control of henbit, wild radish, and common chickweed if applied when these weeds are small ($\leq$2 inch). Osprey is VERY effective on annual bluegrass but does not control little barley.

The rotational restriction following Osprey application is 30 days for barley and sunflower; 90 days for cotton, peanut, soybean, rice, lentils, peas, and dry beans; 12 months for corn; and 10 months for other crops.

Resistance to Osprey and PowerFlex is a huge concern; thus, if treating a field with either Osprey or PowerFlex this year, do not apply either product to that field next year.

PowerFlex HL, active ingredient pyroxsulam, can be applied to wheat between three leaf and jointing to control ryegrass with less than two tillers. The current formulation of PowerFlex HL should be a 13.13 WDG where 2.0 oz/A is the appropriate rate. Applications should be made in 12 to 15 gallons of water per acre and include a crop oil concentrate at 1 to 1.25% v/v (1 to 1.25 gal crop oil per 100 gal spray solution). Four-hour rain fast period is needed.

In addition to ryegrass, the PowerFlex HL label claims control of several broadleaf weeds including Carolina geranium, common chickweed, hairy vetch, wild mustard and suppression of henbit. The label does not mention wild radish but numerous Georgia studies suggest excellent control of wild radish up to 8 inches in height.

For additional broadleaf control, PowerFlex HL may be mixed with Harmony Extra. Do not mix with dicamba, 2,4-D, or MCPA. Also, do not mix with or spray within 5 days of organophosphate insecticides.

Do not fertilize with an independent liquid ammonium nitrogen application within 7 days before or after a PowerFlex application. However, the label allows for Powerflex to be mixed in water-nitrogen mixtures containing up to 50% liquid nitrogen (<30 lb actual nitrogen per acre). When PowerFlex is applied with nitrogen, use a nonionic surfactant at 1 pt per 100 gallon (0.25% v/v) of solution instead of crop oil. *Consider not mixing PowerFlex with nitrogen fertilizer as a carrier because of the potential for reduced ryegrass control.*

PowerFlex is a sulfonylurea-type herbicide, and similar to other sulfonylureas, PowerFlex works slowly. Symptoms appear three to four weeks after application with up to eight weeks passing before the ryegrass actually dies.

Labeled rotational restrictions include 1 month for wheat and triticale, 3 months for cotton, soybean, grain sorghum, and sunflower, 9 months for grasses including barley, field corn, millet, oats, popcorn, seed corn, sweet corn, and for broadleaves including alfalfa, canola, chickpea, dry bean, field pea, flax, lentil, mustard, potato, safflower, and sugar beet. All crops not listed have a 12 month rotational restriction.

Resistance to Osprey and PowerFlex is a huge concern; thus, if treating a field with either Osprey or PowerFlex this year, do not apply either product to that field next year.

Prowl $H_2 0$, active ingredient pendimethalin, at 1.5 to 2.5 pt/A can be applied postemergence to wheat as long as the wheat has one leaf and before flag leaf is visible. Prowl does not control emerged weeds, but can provide residual control of sensitive weed species if the herbicide is activated by rainfall or irrigation in a timely manner. For ryegrass, Prowl can provide 50 to 80% control at 30 d after application, as long as the Prowl was activated prior to ryegrass germination. Control of wild radish and primrose is usually poor to fair, swinecress fair to good, and henbit is good. The Prowl $H_2 0$ label allows for mixtures with any labeled postemergence wheat herbicide.

The two greatest uses for Prowl $H_2 0$ might be the following: First, a mixture of Prowl $H_2 0$ with a postemergence annual ryegrass herbicide. In theory, with this application the postemergence herbicide would control the emerged ryegrass and the Prowl $H_2 0$ would provide residual control of germinating ryegrass for a couple of weeks. However, it is worth mentioning that most of the ryegrass observed at harvest is not ryegrass that emerged after postemergence herbicide treatment, but rather is ryegrass that was not controlled with a postemergence herbicide because the ryegrass was too large or resistant when treated. Prowl $H_2 0$ will not help with this situation. A second use for Prowl $H_2 0$ would be in a situation where the wheat emerges while the ryegrass is late to emerge. In this situation, Prowl $H_2 0$ applied over one-leaf wheat and activated by rainfall or irrigation could provide control of that later emerging ryegrass.

Zidua, active ingredient pyroxasulfone, can be applied as a delayed preemergence or early postemergence treatment in wheat that is planted between 0.75 to 1.25 inches deep. Currently two formulations of Zidua are available including a 85 WG and a 4.17 SC. Delayed preemergence applications can occur when 80% of the germinated wheat seeds have a shoot at least ½ inch long up until spiking; applications of 0.7 to 1.0 oz/A (85 WG on coarse soils) or 1.25 to 1.75 fl oz/A (4.17 SC on coarse soils) are appropriate for most Georgia fields while the rate can be increased to 1.25 oz/A (85 WG) or 2.3 fl oz/A (4.17 SC) on medium textured soils. Do not irrigate fields treated with a delayed preemergence application until wheat spiking *and DO NOT apply delayed preemergence applications to broadcast-seeded wheat*.

Early postemergence Zidua applications can be applied to wheat at spiking up to the fourth-tiller growth stage at a rate of 1.0 to 2.5 oz/A (85 WG) or 1.75 to 4.0 fl oz (4.17 SC). Sequential applications may also be applied as long as the total use rate does not exceed 2.5 oz/A (85 WG) or 4.0 fl oz (4.17 SC).

If Zidua is activated prior to ryegrass emergence, excellent control is expected; however, if ryegrass is up at time of Zidua application then control of the emerged plants will likely be poor.

Greatest potential for injury occurs when open/cracked seed furrow allows herbicides to directly contact the seed, when seed are planted too shallow, or when seed are planted in a

deep furrow that allows herbicide concentration after a rain/irrigation event during wheat germination.

Herbicide Resistance Management

Herbicide resistance is a natural inherited ability of a plant to survive and reproduce following exposure to a dose of herbicide that normally controls that plant species. Resistant plants are not responsive (or less responsive) to a particular herbicide because of a genetic change within the plant population. Herbicides do not "create" resistant plants; resistant plants are naturally present in very low numbers. Repeated use of the same herbicide, or those herbicides with the same mode of action, may select for resistant plants. Resistant weed populations are allowed to flourish as competition from susceptible species is eliminated by the herbicide treatment.

Ryegrass with resistance to Hoelon has been a problem in Georgia for decades. Osprey and PowerFlex-resistant ryegrass are now common because of their repeated use. During 2009, ryegrass with resistance to Hoelon, Osprey, and PowerFlex was confirmed. And in 2011, several ryegrass populations with resistance to Hoelon, Osprey, Axial, and PowerFlex were confirmed. Additional locations with ryegrass resistance to multiple herbicide modes of action have been confirmed each year since then as well.

One effective way to avoid or delay buildup of herbicide-resistant ryegrass populations is to rotate herbicides with different modes of action within the wheat crop. Of even more importance may be the need of rotating out of wheat and into other cropping systems allowing for the use of herbicide chemistries not used in small grains. Additionally, integration of non-chemical controls, such as crop rotations and cultural control methods including deep turning of the land can delay resistance.

Early detection of herbicide-resistant weeds is important to limit their spread to other fields and farms currently not infested. Since some control failures are not due to weed resistance, growers should eliminate other possible causes of poor herbicide performance before assuming they have resistance. These causes include the following:

1) improper weed identification
2) improper herbicide choice or rate
3) poor/improper application i.e. coverage, spray volume, adjuvants, etc.
4) POOR APPLICATION TIMING
5) unfavorable weather such as excessively cold, wet, dry, etc….
6) weed flushes after herbicide applications
7) antagonism when mixing pesticides
8) time of day in which the herbicides were applied
9) weeds covered by dirt during application
10) rainfall prior to needed rain-free period reducing herbicide absorption
11) lack of rainfall or irrigation to activate residual herbicides

After eliminating possible causes for control failure, then look for known indicators of resistance:

1) poor performance on one species while other species are controlled well
2) product that normally controls a weed in question performs poorly under ideal conditions
3) poor control confined to localized spots in a field, at least initially
4) within a species, some plants are controlled well whereas others are not
5) field history of heavy use of herbicides with same mode of action

Liquid Nitrogen Tank Mixes

Although several herbicides used in wheat may be mixed with liquid nitrogen, herbicide and nitrogen timing for wheat applications likely do not coincide. For example, nitrogen should be applied at full tiller and prior to jointing, whereas herbicides should be applied when the weeds are small and the wheat will not be injured (often before or around Christmas). Stretching the window for effective weed control to accommodate nitrogen fertilization may result in poor weed control and greater wheat injury. *Additionally, using nitrogen fertilizers as a carrier for herbicides can be antagonistic especially when managing annual ryegrass.*

Additional Considerations for No-Till Wheat Production

In no-till production systems, weed control at planting is critical because many winter annual weeds such as chickweed, henbit, annual bluegrass, and Italian ryegrass are already established at planting time. Programs should be developed to remove all weeds prior to seeding wheat. Both paraquat (Gramoxone, etc) and glyphosate are effective tools to manage problematic weeds prior to planting (Tables 12 and 13). Other herbicides such as Select, Harmony Extra, 2,4-D, Quelex and Valor may be applied preplant; however, with the exception of Harmony Extra and Quelex, significant plantback intervals must be followed (Table 13).

A burndown herbicide is recommended in every case of no-till wheat production. Without a burndown, winter annuals can quickly get too large to control and can cause substantial yield reduction. Higher rates of preplant burndown herbicides may be needed for dense weed populations, under drought or cool or cold growing conditions, or for specific problem weeds.

Just as is the case in all other crops, wheat should be planted into fields free from weeds especially ryegrass and wild radish.

Table 14. Weed Responses to Broadleaf Herbicides Used in Wheat.

Weeds	2,4-D[1]	MCPA[1]	Harmony Extra[1]	Harmony Extra + MCPA or 2,4-D[1]	Express + MCPA or 2,4-D[1]	Quelex[1]	Express[1]	Buctril[1]	Peak[1]	Finesse[2]
annual bluegrass	N	N	N	N	N		N	N	N	N
annual ryegrass	N	N	N	N	N		N	N	N	F
buttercup	G		G	GE						G
c. chickweed	P	P	G	GE	GE	GE	G	PF		G
c. ragweed	G	F	PF	FG				E	E	
cornflower	G		P	F				GE		F
cudweed	GE	GE	E	E	E			G		
curly dock	P	P	E	E	P			PF		
dandelion	E	E		GE	GE			E		
dogfennel	G	F	E	E				GE		
evening primrose	E	E	F	E	E			F	FG	
field pennycress	G		G	GE				G		G
geranium	F	F	FG	GE		G				
goldenrod	F	G						F		
hairy vetch	FG	FG	P	F				F		
henbit	P	P	G	GE	G	GE	F	F	FG	G
horsenettle	F	F						F		
horseweed	F	F	FG	FG				F		
knawel	P		G	G				P		
lambsquarters	G	G	E	E				E	G	
plantains	E	E	E	E	E			E		
shepherd's-purse	GE	GE	E	E	E			G	G	G
swinecress	G	G	E	E	GE			GE		
thistles	G	G	FG	G				G	FG	
vetch	G		P					F		
VA pepper-weed	E		G	GE	E			FG		
wild garlic	F	P	GE	GE				P	E	P
wild mustard	E	GE	FG	E	E		F	G	G	G
wild radish	E	GE	FG[3]	E	E	GE[3]	F	FG	G	G

Key: E = excellent control, ≥90%; G = good control, 80% to 90%; F = fair control, 70% to 80%; P = poor control, 25 to 50%; N = no control, ≤ 25%.
[1]Timely postemergence application.
[2]Applied preemergence.
[3] Must be less than 3 inches when treated in good growing conditions.

Table 14. Weed Responses to Grass and Broadleaf Herbicides Used in Wheat (continued).

Weeds	Axiom[2]	Fierce[2]	Zidua[2]	Hoelon[1]	Axial XL[1]	Osprey[1]	PowerFlex[1]
Annual bluegrass	G			N	N	GE	PF
Annual ryegrass	PG[3]	GE[3]	FE[3]	E[4]	GE[5]	GE[6]	GE[6]
buttercup				N	N		
common chickweed				N	N	FG[7]	FG[7]
common ragweed				N	N		
cornflower				N	N	P	
cudweed				N	N		
curly dock				N	N	P	
dandelion				N	N		
dogfennel				N	N		
evening primrose		GE		N	N	P	P
field pennycress				N	N		
goldenrod				N	N		
hairy vetch	F			N	N		
henbit	GE	GE	PF	N	N	GE[7]	FG
horsenettle				N	N		
horseweed				N	N		
knawel				N	N		
Lambsquarters				N	N		
plantains				N	N		
shepherd's-purse				N	N		
swinecress				N	N	E	
thistles				N	N		
vetch				N	N	PF[7]	
VA pepper-weed				N	N		
wild garlic				N	N	P	
wild mustard	G	GE	PF	N	N	G	GE
wild radish	G	GE	PF	N	N	G	GE

Key: E = excellent control, 90% or better; G = good control, 80% to 90%; F = fair control, 70% to 80%; P = poor control, 25 to 50%; N = no control, less than 25%

[1] Timely postemergence application.
[2] Applied spike to wheat.
[3] Axiom provides good control and Zidua provides excellent control if activated prior to ryegrass germination, poor control is often achieved if ryegrass emerges prior to herbicide activation. Fierce will provide excellent control if activated prior to ryegrass reaching ½ inch in height.
[4] Will not control Hoelon-resistant ryegrass.
[5] Axial XL & Hoelon have similar modes of action; Axial XL may not control Hoelon-resistant ryegrass and will not kill Axial-resistant ryegrass.
[6] Will not control Osprey- or PowerFlex-resistant ryegrass.
[7] Weeds must not be larger than 2 inches when treated.

Table 15. Chemical Weed Control in Wheat.

Weeds Controlled	Herbicide, Formulation, and Mode of Action Category[1]	Amount of Formulation (broadcast rate/acre)	Pounds Active Ingredient (broadcast rate/acre)	REMARKS AND PRECAUTIONS (read all labels)
		PREPLANT NO-TILL		
Emerged annual weeds; suppresses volunteer corn	paraquat 2 SL 3 SL MOA 22	 2 to 4 pt 1.33 to 2.7 pt	0.5 to 1.0	**U.S. EPA has restricted the use of paraquat to certified applicators ONLY; applicators must take a specialized training before use.** Apply before crop emerges. Rate depends on weed size. Add nonionic surfactant at 2 pt per 100 gal of spray or crop oil concentrate at 1 gal per 100 gal of spray. Control of 12" corn at 1.5 pt/A is about 80% but may provide acceptable control until frost.
Emerged annual weeds, control or suppression of perennial weeds; use full rate for ryegrass and radish *For severe ryegrass infestations, apply glyphosate and follow 5-7 days later with paraquat*	glyphosate 3.57 SL (3 lb a.e.) 4 SL (3 lb a.e.) 5 SL (3.7 lb a.e) 5.5 SL (4.5 lb a.e.) 5.88 S (4.8 lb a.e.) 6 SL (5 lb a.e.) MOA 9	 32 to 48 fl oz 24 to 36 fl oz 23 to 34 fl oz 22 to 32 fl oz 20 to 30 fl oz 19 to 29 fl oz	0.75 to 1.13	Apply before crop emerges; suggest 3 or more days before emergence. Adjuvant recommendation varies by glyphosate brand used. Cool temperatures, including at night, may slow or even reduce the level of control observed. *For perennial weed control, rate can be increased to 2.25 lb ae following label recommendations (suggest higher rates only before planting).*
Control of most weeds; full glyphosate rate for ryegrass	glyphosate + 2,4-D amine (3.8 L) MOA 9 + 4	see glyphosate + 12 to 16 fl oz	0.75 to 1.13 + 0.36 to 0.48	Check brand of 2,4-D used as some labels prohibit planting within 29 days of application. Research suggests plantback intervals of at least 24 days and 1 inch of rain between application and planting may be needed. Without required rainfall, serious injury can occur. *Quelex offers much less injury potential than 2,4-D.*
Summer and winter annual weeds including wild radish, henbit, chickweed; full glyphosate rate for ryegrass	glyphosate + thifensulfuron-methyl + tribenuron-methyl (Harmony Extra SG with Total Sol) 50 SG	see glyphosate + 0.45 to 0.9 oz	0.75 to 1.13 + 0.0094 to 0.0187 + 0.0047 to 0.0094	May be used as a burndown treatment prior to or shortly after planting, but prior to wheat emergence (suggest at least 3 days before emergence because of the glyphosate).
Volunteer Roundup Ready Corn and ryegrass; full rates for ryegrass	glyphosate + clethodim (Select) 2 EC (Select Max) 0.97 EC MOA 9 + 1	see glyphosate + 4 to 8 fl oz 8 to 16 fl oz	0.75 to 1.13 + 0.06 to 0.13 0.06 to 0.13	**Do not plant wheat for 30 days** after application. Rainfall after application and before planting of 0.5" or more advised. Corn < 12 inch: Select 4–6 oz; Select Max 8-12 oz. Corn 12-24 inch: Select 6–8 oz; Select Max 12-16 oz. Ryegrass 2-6 inch: Select 8 oz; Select Max 16 oz
Summer and winter annual weeds including wild radish, henbit, chickweed; residual control of numerous weeds with ryegrass suppression	glyphosate + flumioxazin (Valor SX) 51 WDG (Valor EZ) 4 SC MOA 9 + 14	see glyphosate + 1 to 2 oz 1 to 2 fl oz	0.75 to 1.13 + 0.032 to 0.064	For Valor, **a minimum of 30 days must pass**, and 1 inch of rainfall/irrigation must occur, between application and planting of wheat. On sands, a plant back interval of 40 days is suggested. Significant injury is likely without rainfall.
Chickweed, C. geranium, henbit, horseweed, soybean, wild radish; use full glyphosate rate for ryegrass	glyphosate + halauxifen-methyl + florasulam (Quelex) 0.2 WG MOA 4 + 2	see glyphosate + 0.75 oz	0.75 to 1.13 + 0.0048 + 0.0047	Apply as a preplant burndown treatment prior to, or shortly after planting prior to emergence; suggest at least 3 days prior to emergence because of the glyphosate. Weeds should be less than 4 inches. Label requires addition of non-ionic surfactant or crop oil concentrate. An application can be made for burndown and again in-crop, see below. Rotation to cotton/soybean is 3 months. UGA research shows excellent crop tolerance to Quelex.

Weeds Controlled	Herbicide, Formulation, and Mode of Action Categlory[1]	Amount of Formulation (broadcast rate/acre)	Pounds Active Ingredient (broadcast rate/acre)	REMARKS AND PRECAUTIONS (read all labels)
		PREEMERGENCE		
Annual ryegrass and annual broadleaf weeds; although ryegrass control is often variable.	chlorosulfuron + metsulfuron-methyl (Finesse) 75 WDG MOA 2 + 2	0.5 oz	0.0195 + 0.0039	May stunt wheat on sandy soils; wheat seed must be planted at least 1” deep. Do not use where a later application of Osprey or PowerFlex is expected. **Plant only STS soybeans 6 or more months after application.** Crop injury may result if organophosphate is used. SEE rotational restrictions. Rate can be lowered if only managing broadleaf weeds.
		DELAYED PREEMERGENCE		
Ideal use is for residual control of ryegrass resistant to POST herbicides	Pyroxasulfone (Zidua) 85 WG (Zidua) 4.17 SC MOA 15	0.7 to 1.0 1.25 to 1.75 fl oz	0.037 to 0.053	Suggest planting wheat seed 0.75-1.25” deep. Can not apply to broadcast seedings. Seed must be uniformly covered without furrows to avoid injury. Apply Zidua as a broadcast spray to the soil surface following wheat planting when 80% of germinated wheat seeds have a shoot at least ½ inch long up through wheat spiking. Rate can be increased to 0.075 lb ai on medium texture soils, see label. Label restricts irrigation until wheat is emerged. Avoid application if a long period of rain is expected prior to wheat emergence. **To minimize resistance:** *If treating a field with either Zidua or Fierce this year, do not apply either product on that field next year.*
		POSTEMERGENCE: SPIKE TO EARLY POST (FOR USE IN FIELDS WITH RYEGRASS RESISTANT TO POST HERBICIDES)		
Ryegrass resistant to POST herbicides, radish, henbit and annual bluegrass; must be activated before emergence	flufenacet + metribuzin (Axiom) 68 WDG MOA 15 + 5	4 to 8 oz	0.136 to 0.027 + 0.034 to 0.068	Wheat seed should be planted at least 1 inch deep. Apply to wheat between spike and 2 leaf. Preemergence applications can cause severe injury on light soils. For most GA soils, ≤6 oz/A of product is ideal. Heavy rains following application can cause wheat stunting. Rotation: soybean = 0 months, cotton = 8 months, many other crops = 12 months; many root crops 18 months.
Residual control of annual ryegrass; will not control emerged plants and must be activated before ryegrass emergence	pyroxasulfone (Zidua) 85 WG (Zidua) 4.17 SC MOA 15	1 to 2.5 oz 1.75 to 4 fl oz	0.53-0.133	Apply to wheat (drilled or broadcast) between spiking and 4 tiller. Lower rate on coarse soils and young wheat. *Sequential applications may be made as to not exceed 2.5 oz/A of the dry formulation or 4 oz/A of the liquid formulation.* **To minimize resistance:** *If treating a field with either Zidua or Fierce this year, do not apply either product on that field next year.*
Residual control of annual ryegrass, wild radish, and other weeds Fierce must be activated prior to weeds being ¼” for excellent control.	pyroxasulfone + flumioxazin (Fierce) 76 WDG MOA 15 + 14	1.5 oz	0.04 + 0.032	**Section 24 (c) Georgia Local Need Label.** Plant seed 1 to 1.5 inch deep; cannot treat broadcast seedings. Apply to wheat from spike to 2-leaf stage; DO NOT apply preemergence. Apply only in water; no additives. Visual leaf tip burn and chlorosis is expected. Ideally, Fierce is activated after wheat is up but before weed emergence. No rotational concern following wheat with cotton, peanut, soybean or corn. NOTE: During 2022-2023, this label is expected to be transitioned over to the liquid formulation on the Fierce EZ federal label, make sure to adjust rate accordingly (3 fl oz/A). **To minimize resistance:** *If treating a field with either Zidua or Fierce this year, do not apply either product on that field next year.*

Weeds Controlled	Herbicide, Formulation, and Mode of Action Categlory[1]	Amount of Formulation (broadcast rate/acre)	Pounds Active Ingredient (broadcast rate/acre)	REMARKS AND PRECAUTIONS (read all labels)
			POSTEMERGENCE	
Common chickweed, C. geranium, henbit, horseweed, soybean, small wild radish	halauxifen-methyl + florasulam (Quelex) 0.2 WG MOA 4 + 2	0.75 oz	0.0048 + 0.0047	Apply to wheat between 2-leaf and flag leaf. Weeds should be less than 4". Weeds stressed from cold or drought may not be controlled. Include crop oil concentrate (0.5 to 1% v/v). See label regarding mixing with liquid nitrogen. Rotation of 3 months for cotton, corn, and soybean and 9 months for peanut. UGA research shows excellent control of small radish but less effective on larger plants.
Non-resistant annual ryegrass, small wild radish, and other broadleaf weeds Very effective on annual bluegrass	mesosulfuron-methyl (Osprey) 4.5 WDG MOA 2	4.75 oz	0.013	Apply to wheat between emergence and jointing to control ryegrass with less than 2 tillers. Add a nonionic surfactant (at least 80% active) at 2 qts per 100 gallon spray solution plus ammonium nitrogen fertilizer (28-0-0, 30-0-0, 32-0-0) at 1 to 2 qt/A. **DO NOT** top-dress within 14 days of Osprey application or mix with 2,4-D or MCPA. Do not use liquid nitrogen as the carrier. May mix with Harmony Extra. Cotton/soybean can be planted 90 days after application. **To minimize resistance:** *If treating a field with either Osprey or PowerFlex this year, do not apply either product on that field next year.*
Non-resistant emerged annual ryegrass	pinoxaden + fenoxaprop-p-ethyl (Axial Bold) 0.685 EC MOA 1 + 1	15 fl oz	0.054 + 0.027	Apply to wheat between emergence and pre-boot to control ryegrass with less than 2 tillers. No adjuvant mentioned on label. May mix with Harmony Extra for broadleaf control. UGA data suggests not mixing with nitrogen but label allows water/nitrogen mixtures containing up to 50% liquid nitrogen by volume; add water to tank, then add Axial; then mix thoroughly and add nitrogen. One application per crop and any crop can be planted 90 days later. **To minimize resistance:** *If treating a field with Axial this year, do not apply it on that field next year.*
Non-resistant annual ryegrass, also very effective on wild radish and several other broadleaf weeds	pyroxsulam (PowerFlex HL) 13.13 WDG MOA 2	2.0 oz	0.0164	Apply to wheat between 3 leaf and jointing to control ryegrass with less than 2 tillers. Add crop oil concentrate at 1 to 1.25 % v/v. May tank mix with Harmony Extra. UGA data suggests not mixing with nitrogen but label allows water-nitrogen mixture containing up to 50% liquid nitrogen by volume (< 30 lb/A of nitrogen). If applying in nitrogen, use a nonionic surfactant at 0.25% v/v, instead of crop oil. An independent liquid ammonium nitrogen fertilizer application should not be made within 7 days of application; do not apply organophosphate within 5 days of application. As a rotation crop, soybeans and cotton may be planted 3 months following application. ***Ryegrass resistant to Osprey or PowerFlex is* common.** **Minimize resistance:** *Apply either Osprey or PowerFlex only once on the same field over a two year period.*

Weeds Controlled	Herbicide, Formulation, and Mode of Action Categlory[1]	Amount of Formulation (broadcast rate/acre)	Pounds Active Ingredient (broadcast rate/acre)	REMARKS AND PRECAUTIONS (read all labels)
POSTEMERGENCE (continued)				
Fair residual suppression of annual ryegrass	pendimethalin (Prowl H20) 3.8 AS MOA 3	1.5 to 2.5 pt	0.71 to 1.19	Apply to wheat after 1 leaf and before flag leaf. Prowl does not control emerged weeds and must be activated prior to weed emergence. May tank mix with any postemergence herbicide labeled for use in wheat. *Zidua is more effective on ryegrass.*
Wild garlic, curly dock, and most winter annual broadleaf weeds except wild radish should be less than 1"	thifensulfuron-methyl + tribenuron-methyl (Harmony Extra SG with TotalSol) 50 SG (Harmony Extra, Nimble, others) 75 WDG MOA 2 + 2	0.45 to 0.9 oz 0.3 to 0.6 oz	0.0094 to 0.0187 + 0.0047 to 0.0094	Apply to wheat after 2 leaf and before flag leaf. Most annuals can be controlled with 0.75 oz/A of Harmony Extra 50 SG; however, 0.75 to 0.9 oz/A is recommended for controlling wild garlic or very small wild radish. Apply to non-stressed weeds with less than 4 leaves when temperatures are above 50 F. Garlic should be < 12" tall and should have 2-4" of new growth. Make no more than 2 applications per year applying a max of 1.5 oz/A per season of Harmony Extra Total Sol or equivalent active ingredient with other products. A nonionic surfactant at the rate of 1 quart per 100 gal of spray solution is suggested when applied in water. Liquid nitrogen may be used as the carrier; in this case, premix the herbicide in water and add the mixture to nitrogen with agitation; add 0.5 to 1.0 pint nonionic surfactant per 100 gallons spray solution. **For wild radish, consider a** tank mix with MCPA or 2,4-D at 0.375 to 0.5 lb ai/A (12-16 oz/A of 3.8 lb ai material). Add 0.5 to 1.0 pint nonionic surfactant per 100 gallons spray solution, surfactant rate can be increased to 1 qt but expect more injury. If mixing 2,4-D or MCPA with Harmony and using nitrogen as the carrier, eliminate surfactant. Follow wheat growth restrictions for 2,4-D or MCPA.
Partial control of most weeds including wild radish Harmony Extra is usually more effective	tribenuron-methyl (Express SG with TotalSol) 50 SG (Express) 75 WDG MOA 2	0.25 to 0.5 oz 0.167 to 0.33 oz	0.008 to 0.0155	Apply to wheat after 2 leaf and before flag leaf. Add 1 qt of nonionic surfactant per 100 gal of spray solution. Consider mixtures with 0.375 to 0.5 lb active ingredient of 2,4-D or MCPA for improved control of wild radish (add 0.5 to 1.0 pint nonionic surfactant per 100 gallons spray solution). If mixing 2,4-D or MCPA with Express and using nitrogen as the carrier, use at most 0.5 pt of nonionic surfactant per 100 gallons of spray solution. Follow wheat stage of growth restrictions for MCPA or 2,4-D when using these mixtures.
Most winter annual broadleaf weeds except chickweed, henbit, knawl, red sorrel, and geranium	2,4-D amine (various brands) 3.8 L 2,4-D ester (various brands) 3.8 L 2,4-D ester (various brands) 5.5 L MOA 4	1.0 to 1.25 pt 1.0 to 1.25 pt 0.67 to 0.84 pt	0.48 to 0.6 0.48 to 0.6 0.48 to 0.6 0.35 to 0.43	Apply to fully tillered wheat only. Spraying wheat too young or after jointing may reduce yields. Better results obtained when day-time temps are above 50 F. For corn cockle, wild onion, and wild garlic, rate can be increased to 2 pt/A (of 3.8 lb product) but crop injury is expected. Injury is increased when using liquid nitrogen as the carrier. Ester formulations can be added directly into nitrogen. If using amine formulation, premix in water (1 part 2,4-D to 4 parts water) and add mixture to nitrogen with strong agitation. Amine formulations give less burn than ester formulations in nitrogen. Ester formulations may be more effective on weeds in very cold conditions. Amine formulations are suggested to minimize off-target movement. **Consider mixtures with Harmony Extra as noted above or with Quelex.** One in-season application only.
	MCPA (various brands) 4.0 L (various brands) 3.7 L MOA 4	12 to 20 fl oz 11 to 19 fl oz	0.375 to 0.625 0.347 to 0.55	Apply 12 to 16 oz/A when wheat has tillered and 16 to 19 oz/A when fully tillered but before boot stage. Safer on wheat than 2,4-D; slightly less effective on larger weeds when applied alone. No spray additive required. Consider **mixtures with Harmony Extra as noted above or with Quelex.** Amine formulations are suggested to minimize off-target movement.

Weeds Controlled	Herbicide, Formulation, and Mode of Action Categlory[1]	Amount of Formulation (broadcast rate/acre)	Pounds Active Ingredient (broadcast rate/acre)	REMARKS AND PRECAUTIONS (read all labels)
		PRE-HARVEST		
Annual broadleaf and grass weeds, suppression of perennial weeds	glyphosate 3.57 SL (3 lb a.e.) 4 SL (3 lb a.e.) 5 SL (3.7 lb a.e) 5.5 SL (4.5 lb a.e.) 6 SL (5 lb a.e.) MOA 9	 2.6 pt 2 pt 1.6 pt 22 fl oz 20 fl oz	0.75	Apply after hard dough stage of grain (30% or less grain moisture) but at least 7 days before harvest. **Do not apply to wheat grown for seed.** A wiper application could be used for only rope/sponge applicators (33 to 75% of solution with water) or a panel applicator (33 to 100% of solution with water); do not use a roller applicator. Do not add a surfactant, and there is a 35 day pre-harvest interval for wiper applications.
Annual broadleaf weeds	2,4-D amine (various brands) 3.8 SL MOA 4	1 pt	0.48	Apply when grain is in the hard dough stage (30% or less grain moisture) or later. DO NOT allow drift to sensitive crops. **Use only amine formulations to reduce volatility** as sensitive crops are likely nearby during this time of year. Pre-harvest interval of 14 days required.

[1]Mode of Action (MOA) code developed by the Weed Science Society of America. MOA codes can be used to increase herbicide diversity in a weed management program to delay the development of resistant weeds.

Important Note: Observations in Georgia wheat fields indicate crop damage when 2,4-D is tank mixed with liquid nitrogen. This also may be evident with other herbicide-nitrogen mixtures. To avoid possible damage and obtain better weed control, herbicides and nitrogen should be applied separately.

Table 16. Forage, Feed, and Grazing Restrictions for Wheat Herbicides.

Trade Name	Restrictions (see label of product used as label restrictions vary by product)
Axial Bold	Do not graze or harvest wheat forage or cut wheat hay within 30 days of application. Do not harvest grain or feed straw to livestock for at least 70 days after application.
Axiom	Do not graze within 30 days of application.
Express or Harmony Extra Total Sol	Allow 7 days between application and grazing treated forage or feeding forage to livestock. Allow 30 days between application and feeding of hay to livestock. Allow at least 45 days before harvesting grain. Harvested straw may be used for bedding and/or feed.
Fierce	Do not graze until wheat has reached 5 inches in height.
Finesse	No grazing restrictions.
MCPA	Do not forage or graze meat animals or dairy cattle within 7 days of slaughter.
Osprey	Do not apply within 30 days of harvesting wheat forage, and 60 days for hay, grain, and straw.
PowerFlex	Do not graze treated crop within 7 days following application. Do not cut the treated crop for hay within 28 days after application.
Prowl H20	Do not apply within 28 days of harvest of hay; within 11 days of harvest of forage; or within 60 days before harvest of grain or straw.
Quelex	Do not apply closer than 21 days before cutting of hay. Do not allow livestock to graze on treated crops for 7 days following application. Do not compost any plant material from treated area.
RU PowerMax	Allow a minimum of 7 days between application and harvest or grazing. Stubble may be grazed immediately after harvest.
Zidua	Wheat forage and hay can be fed or grazed 7 or more days after application.
2,4-D	Do not graze dairy animals within 7 days of application. Do not cut treated grass for hay within 7 days of application. Remove meat animals from treated areas 3 days prior to slaughter.

Insect Pest Management

David Buntin

Overview

This chapter discusses the major insect pests of wheat. Insect pests can reduce both grain yield and quality of small grain crops in Georgia. Historically, the Hessian fly, aphids, and cereal leaf beetle are the pests of significant economic importance. Aphids can directly damage wheat, but are of concern mostly because they transmit a viral disease called barley yellow dwarf (BYD). True armyworm and other insects also occasionally damage cereal grain crops.

Major Insect Pests of Wheat

Aphids

Aphids are small, soft-bodied insects that can be found in wheat anytime during the growing season. The most common aphids found on wheat are the bird cherry-oat aphid, rice root aphid, greenbug, corn leaf aphid, and English grain aphid. The first four occur mostly in the fall and winter. Only the greenbug causes direct feeding damage that appears speckled brown and discolored with some leaf curling. The other aphids usually do not cause obvious feeding damage. The English grain aphid is mainly present in the spring and can reach large numbers on flag leaves and developing grain heads. Damage from this pest can reduce kernel size and lower grain test weight. Aphids are a serious pest of wheat because they also transmit a viral disease named barley yellow dwarf (BYD) and a related disease called cereal yellow dwarf. Wheat and barley can be severely damaged, but oats are most susceptible to this disease. A new aphid, Sipha maydis, has been found in the Southeast on wheat which also can transmit BYD but its impact on wheat production in Georgia is limited.

BYD is present in most fields in most years throughout Georgia. Yield losses are sporadic but losses of 5-15% are common and can exceed 30% during severe epidemics. Infection can occur from seedling emergence through heading, but yield loss is greatest when plants are infected as seedlings in the fall. Although all aphids can potentially transmit certain strains of the virus, infections in the Southeast are mostly associated with infestations of bird cherry-oat aphid and rice root aphid. Planting date is the single most important management practice, with early plantings having greater aphid numbers and greater BYD incidence than late plantings. For the most part, beneficial insects such as lady beetles are helpful in reducing aphid numbers in the fall before frost and in the spring, but they are not active during the winter when aphids can quickly increase to large numbers during warm periods.

Systemic seed treatments are available for controlling aphids in the fall and winter and may reduce infection rates of BYD. These seed treatments are more effective in the northern half of the state, but are only recommended when (1) grain yield potential is high (>60 bu/acre), (2) a field has a history of BYD infection, and/or (3) early plantings will be made. In the coastal plain region, seed treatments have been inconsistent in control and are not recommended for

routine aphid control. A single, well-timed insecticide application of the insecticide lambda cyhalothrin (Warrior II, Silencer, and similar products) or gamma cyhalothrin (Declare) also can control aphids, reduce the incidence of BYD, and increase yields. The best time for treatment in northern Georgia usually is about 25 - 35 days after planting, although an application in the winter until full tiller also may be beneficial. In southern Georgia, the best treatment time usually is at full-tiller stage in late January to mid-February. But, scout fields for aphids at 25 - 35 days after planting and during warm periods in January to determine if an insecticide application is needed. A lambda cyhalothrin or gamma cyhalothrin treatment at full tiller can be applied with top-dress nitrogen. Two new insecticides, Sivanto Prime and Transform WG, also will provide useful control but its effect on BYD infection has not determined. OP insecticides, such as dimethoate, also will control aphids but are not effective in preventing barley yellow dwarf infection.

To sample aphids, inspect plants in 12 inches of row in fall and 6 inches of row in winter. In spring, inspect 10 grain heads (+ flag leaf) per sample. Count all aphids on both the flag leaf and head for making control decisions. Sample plants at 5 to 10 locations per field. Treat when populations reach or exceed the following thresholds:

Seedlings: 1 bird cherry-oat aphids per row foot, or 10 greenbugs per row foot.
2 or more tillers per plant: 6 aphids per row foot.
Stem elongation to just before flag leaf emergence: 2 aphids per stem.
Flag leaf emergence: 5 aphids per flag leaf.
Heading emergence to early dough stage: 10 aphids per head.
Do not treat for aphids after mid-dough stage.

Hessian Fly

The Hessian fly, *Mayetiola destructor*, can cause severe damage to wheat production throughout the southern United States. Wheat is the primary host of the Hessian fly, but the insect also will damage triticale. Barley and rye also may be infested but damage normally is very limited. Hessian fly does not attack oats. Little barley is the only important non-crop host in Georgia.

Adult Hessian flies are small black flies about the size of a mosquito. Adults live about two days and females lay about 200 eggs in the grooves of the upper side of the wheat leaves. Eggs are orange-red, 1/32 inch long and hatch in 3 to 5 days. Young reddish larvae move along a leaf groove to the leaf sheath and then move between the leaf sheath and stem where they feed on the stem above the leaf base. Maggots become white after molting and appear greenish white when full grown. Once larvae move to the stem base, they are protected from weather extremes and foliar-applied insecticides. Maggots suck sap and stunt tillers presumably by injecting a toxin into the plant. Infested jointed stems are shortened and weakened at the joint where feeding occurs. Grain filling of infested stems is reduced and damaged stems may lodge before harvest. Generally, three generations occur in the Piedmont region and four generations occur in the Coastal Plain region of Georgia. The fall and winter generations stunt and kill

seedling plants and vegetative tillers. The spring generation infests jointed stems during head emergence and grain filling. Yield losses usually occur when fall tiller infestations exceed 8% of tillers and when spring stem infestations exceed 15% of stems.

The Hessian fly is a cool season insect and is dormant over the summer in wheat stubble as a puparia which is sometimes called a ‘flaxseed’. Adults begin to emerge about September 1. Since wheat is not yet planted, the first generation develops entirely in volunteer small grains and little barley. Thus, reduced tillage, lack of crop rotation (wheat after wheat), and lack of volunteer wheat control in summer crops enhance problems with Hessian fly in autumn.

Planting a Hessian fly-resistant variety is the most effective way to control Hessian fly. Varieties in the Georgia state wheat variety trials are evaluated for Hessian fly resistance each year and these ratings also are available in the Small Grain Performance Tests Bulletin. But also check the “Characteristics of Recommended Varieties” section in the first part of this publication, because some varieties may not be recommended due to agronomic problems.

For susceptible varieties, systemic seed treatments, such as Gaucho, Cruiser, or NipsIt Inside, when applied at a **high rate will suppress fall infestations but will not prevent Hessian fly infestation** in winter or spring. In February through mid-March, a properly-timed foliar application of lambda cyhalothrin also may suppress spring infestation but consistent control is difficult. This application must be applied while adults are active and eggs are being laid, so sampling of eggs on leaves is needed for proper timing.

<u>*Cereal Leaf Beetle*</u>

Cereal leaf beetle, Oulema melanopus, was first discovered in northwest Georgia in 1989. The insect is spreading southward and now occurs throughout the mountain and Piedmont regions and in most of the upper coastal plain region. Larvae feed on many grasses including oats, wheat, barley, rye, orchard grass, and annual ryegrass, but the insect is a problem mostly on oats and wheat. Adult beetles are 5 mm long and blue-black with a reddish thorax (neck) and legs. Larvae are yellow-white and up to 6 mm long, but appear shiny and black, because they are covered with fecal material. Adults and larvae defoliate or skeletonize long narrow sections of the flag and upper leaves. Adults are present in wheat during March and April when they mate and lay eggs. Larvae are present during wheat head emergence through dough stage. There is one generation per year; newly-emerged adults over summer and overwinter in fence rows and wooded areas. These adults will feed on green grasses in adjacent fields, such as corn, sorghum, and crabgrass, before moving to over-summering sites. Corn planted next to wheat fields can be damaged by the beetles, although damage to corn usually is confined to field margins.

Cereal leaf beetle can be effectively controlled by one application of an insecticide to foliage. Fields should be scouted by counting the number of larvae and adults on 10 stalks at 6 to 10 locations per field. Treatment should be considered when populations exceed 1 larva per 4 stems. Most insecticides should be applied after most eggs have hatched but before larval

damage becomes extensive. Tank mixing with a foliar fungicide at heading time is usually feasible.

Fall Armyworm

Fall armyworm looks much like other armyworm species. It is brown to black in color with an invert Y on its head and four dots spaced in a square on the upper side last abdominal segment. Fall armyworms cannot tolerate freezing temperatures and die out in Georgia each fall. The moths are migratory and fly up from southern Florida each spring. There are several generations and in outbreak years they heavily infest and damage pastures grasses in late summer and the fall. In these year fall armyworm also may infest seedling cereal grains especially fields planted early for grazing. If present, larvae can complete destroy a seedling stand of cereal grains. Field should be scouting soon after planting and an insecticide used if larvae are present and damage is occurring.

True Armyworm

The true armyworm looks much like other armyworm species. It is brown to black in color. Larvae have three, orange, white and brown stripes running the length of each side. The larvae will also have a narrow-broken stripe down the center of its back. Wheat fields should be checked for the presence of true armyworms when wheat is heading usually in March and early April, two weeks later in north Georgia. Armyworms generally are active at night and rest during day under plant residue at the base of stems. Armyworms chew large irregular holes in leaves generally from the bottom up, but may climb stems and cut grain heads off the plant. Very large infestation sometimes will march (crawl) in large numbers out of defoliated wheat fields to continue feeding on crops in nearby fields. Treatment should be considered if 4 or more worms per square foot are found before pollen-shed stage and if 8 or more worms per square foot are found after pollen-shed stage. Insecticides listed are effective but coverage of dense foliar and lodged plants sometimes makes control difficult.

Stink bugs

Wheat is often infested with stink bugs in spring during grain fill. The brown and southern green stink bugs may reproduce and have a complete generation in wheat before harvest. Rice stink bug adults also are common in wheat. As wheat dries down, stink bug adults will disperse to nearby summer crops such as corn and vegetable crops. Stink bugs almost never require control in wheat. Treat if 1 or more bugs per square foot are present at milk stage. Treatment is not needed in the dough stage, except to prevent dispersal to adjacent summer crops as wheat matures. However, stink bugs are highly mobile and, in most cases, it is best to sample and treat adjacent crops such as corn and vegetables when stink bugs move into and reach threshold levels in those summer crops.

Sampling for Insect Pests

Wheat should be scouted for aphids, cereal leaf beetle and secondary pests. Scout the entire field. Insects tend to clump, and thus an examination of the whole field should be made. Fields

should be inspected soon after planting to verify timely emergence. If emergence is poor, the field should be checked for soil-inhabiting insects such fall armyworm before replanting.

After stand establishment, scout fields for aphids at 4 critical times: 25 - 45 days after planting, warm periods in January, full-tiller in mid-February, and boot stage to head emergence. The first three periods are intended to control BYD infection and some direct aphid damage; the last period is to prevent damage by grain aphids, armyworms and cereal leaf beetle.

To sample aphids, inspect plants in 12 inches of row in fall and 6 inches of row in winter. In spring, inspect 10 grain heads (+ flag leaf) per sample. Sample plants at 8 to 16 locations per field. Treat according to thresholds listed for aphids. Inspect fields for cereal leaf beetle adults and larvae weekly for several weeks beginning at boot stage. Count the number of larvae and adults on 10 stalks at 6 to 10 locations per field. No other insect pest justifies routine sampling in wheat except possibly inspecting fields for armyworms during a boot stage while sampling for aphids and cereal leaf beetle.

Insecticides

Except for the Hessian fly, most other insect pests can be controlled by applying foliar insecticides when population densities exceed economic thresholds (Table 17). Systemic seed treatments such as Gaucho 600, Cruiser 5FS, or NipsIt Inside may control aphids, suppress BYD infection and at high rates control Hessian fly in the fall. Most insecticides registered for use on wheat also can be used on oats, rye, and barley with the exception of Transform WG, Fastac, Tombstone and similar products. For current insecticide recommendations see the most recent edition of the Georgia Pest Management Handbook, Commercial Edition.
http://www.caes.uga.edu/departments/entomology/extension/pest-management-handbook.html.

Summary of Management Practices for Insect Pest Control

1. Avoid continuous planting of wheat in the same field including wheat as a cover crop.
2. Control volunteer wheat.
3. Plow fields to bury wheat debris (burning wheat stubble is not effective without tillage).
4. Do not plant wheat for grain before the recommended planting date for your area.
5. Plant rye, oats, or ryegrass instead of wheat for grazing.
6. Select a Hessian fly resistant variety that is adapted to your area.
7. On Hessian fly susceptible varieties, consider using a systemic seed treatment if the field has a history of Hessian fly damage, is reduced tillage, or if planting before the recommended planting date.
8. Scout wheat periodically for aphids, true armyworms, and cereal leaf beetles. Apply a foliar insecticide if numbers exceed treatment thresholds.

Table 17. Damage symptoms and Economic Thresholds of Insect Pests of Wheat

Insect	Damage Symptoms	Treatment Threshold
Aphids	Suck plant sap and may cause yellowing and death of leaves. Reduce grain size when grain heads infested. Transmit barley yellow dwarf virus.	Seedlings: 1/row ft 6-10-inch plants: 6/row ft Stem elongation: 2 per stem Flag leaf – head emergence: 5/stem Full heading: 10/head to include flag
Hessian fly	Vegetative plants – tillers stunted dark green, tiller death; Jointed stems – stunted, weakening of stem at point of feeding injury. Reduced grain size and weight. Infested stems may lodge before harvest.	Fall – early winter: 8% infested tillers Spring: 15% infested stems
Cereal leaf beetle	Adults chew elongated holes in upper leaves, larvae remove leaf tissue leaving low epidermis causing "window pane" effect.	1 larvae or adult per 4 stems
Chinch bugs	Suck plant sap causing discoloration.	Seedlings: 1 adult/2 plants Spring: 1 adult/stem
True armyworm	Primarily occur in late winter and spring from stem elongation to maturity; chew foliage and seed head glumes, also clip awns and seed heads.	Before pollen shed: 4 or more worms/sq ft After pollen shed: 8 or more worms/sq ft.
Fall armyworm, beet armyworm, & yellow striped armyworm	Primarily occurs in the fall; small larvae cause "window pane" feeding on leaves; larger larvae consume leaves and plants and destroy stands	Do not treat unless seedling damage exceeds 50% defoliation and 2 or more armyworms per sq. ft. are present.
Grasshoppers	Destroy leaves of seedlings during fall. Damage common along field margins.	Do not treat unless damage exceeds 50% defoliation and 3 or more grasshoppers / sq yd are present.
Flea beetles	Destroy leaves of seedlings in fall. Damage common along field margins.	Do not treat unless seedling damage exceeds 50% defoliation and 2 beetles /row ft. are present.
European corn borer	Small larvae chew holes in leaves; large larvae tunnel in stem killing developing grain head.	Control almost never practical; Treat when larvae are small, borers numerous and before they bore into stems.
Mites, winter grain mite	Suck plant sap; cause leaf discoloration.	Treat when leaf discoloration appears over areas of a field. Usually in spots.
Thrips	Suck plant sap; may cause leaf discoloration.	Injury not economic; do not treat. Thrips may disperse to adjacent summer crops as wheat matures.
Stink bugs	In spring, feed on developing grain from milk to hard dough stage.	Treat if 1 or more bugs per sq. ft. at milk stage. Do not treat in dough stage.

Disease Management in Wheat

Alfredo Martinez-Espinoza

Overview

The most effective and economical method to control diseases of wheat is to plant disease resistant varieties. Resistance is the primary means to manage foliar diseases, which cause the greatest yield reduction each year. However, few recommended varieties have "good" or high resistance to all the major foliar diseases. In addition, populations of fungi causing leaf rust and powdery mildew are constantly changing. There are numerous strains or races of these fungi. When a new variety is released, it is usually resistant to the most commonly occurring races of the fungi prevalent at that time. The race population can change rapidly. Certain individual races or new races may become more common. If a variety is not resistant to these races of the fungus, it can become severely diseased. This may happen as quickly as a year after the release of a new variety. Varietal recommendations are modified each year, often as a result of changes in disease susceptibility. Refer to the most recent information about the best varieties to grow in this guide and in the annual variety performance bulletin located.
https://swvt.uga.edu/winter-crops/wheat.html

Weather conditions during the winter and spring can have a major effect on the incidence and severity of disease (Table 18). If the winter and spring are cool and/or dry, leaf diseases will usually be of little or no significance regardless of a variety's resistance. A warm, wet winter and spring are favorable for infection by disease-causing fungi. This results in more severe disease. New fungal races also increase more rapidly under such conditions. The combination of low resistance and warmer than normal winters and springs are favorable for severe powdery mildew, leaf rust, and Stagonospora nodorum leaf and glume blotch, the three most important fungal diseases. *Stagonospora nodorum* was formerly named *Septoria nodorum*. These conditions lead to an increased use of foliar fungicides to control diseases on susceptible varieties.

Seedborne and soilborne diseases are controlled primarily by seed treatment and crop rotation. Resistance is generally not available for these diseases. Following planting and fertility management recommendations all contribute to successful disease management for these and other diseases.

Among the diseases of wheat, viruses are often the most difficult to control. Three virus diseases occur on wheat in Georgia: soilborne mosaic, wheat spindle streak mosaic, and barley yellow dwarf. Most varieties have good tolerance to soilborne mosaic and wheat spindle streak. Tolerance or resistance to barley yellow dwarf is fair to low for most varieties.

FHB also called scab, is a devastating and dangerous disease of wheat and barley with worldwide distribution. The disease causes yield loss, low-test weights, low seed germination, and contamination of grain with mycotoxins. A vomitoxin called deoxynivalenol (DON) is

considered the primary mycotoxin associated with FHB. This mycotoxin is subject to regulatory limits by the U.S. Food and Drug Administration (FDA). While the incidence and severity of FHB (Fusarium Head Blight) was low in 2018. FHB incidence and severity has been high throughout the state from 2014 to 2017.

Foliar Diseases

Powdery Mildew

This disease may occur on any above ground plant part, but it is usually most prevalent on the upper surface of the lower leaves. The conspicuous white to gray patches of fungus appear early in the season. When powdery mildew is severe, the entire leaf turns yellow and dies. Black spore-producing structures develop in older lesions. Dense stands, high nitrogen fertility, and rapid growth increase susceptibility. Under such conditions a variety listed as having "good" resistance may become heavily infected. As the stem elongates and temperatures increase, conditions become less favorable for powdery mildew. This disease has the least effect on yields of any of the three diseases discussed in this guide. On all but the most susceptible varieties, powdery mildew confined to the lower leaves has little or no effect on yield. Fungicides should not be applied until flag leaf emergence unless a variety is very susceptible. If fungicide is applied too early, the plant will not be protected during the latter half of the grain-filling period. A complete description, diagnosis and management is now available. http://extension.uga.edu/publications/detail.cfm?number=C1059 (circular 1059)

Leaf Rust

Reddish-brown pustules develop on leaves and sheaths. These pustules are filled with spores of the fungus. Rubbing an infected leaf will leave rusty colored areas on your fingers. Rust pustules may be very tiny, barely large enough to see with the naked eye, to 1/8 inch in length. Generally, varieties with higher levels of resistance will have smaller pustules than varieties with lower levels of resistance. Varieties with poor resistance will also have larger yellow halos around the pustules. Leaf rust has the greatest effect on yield of the diseases discussed here because it develops rapidly during favorable weather. A complete description, diagnosis and management is now available.
http://extension.uga.edu/publications/detail.cfm?number=C1060 (circular 1060)

Stripe Rust

Also known as yellow rust. Pustules coalesce to produce long yellow stripes between veins of the leaf and sheath. Small yellow, linear lesions occur on floral bracts. These pustules are filled with spores of the fungus. In Georgia, the disease appears in late February early March during cool, overcast and wet weather. Stripe rust occurs well before leaf rust. Stripe rust is an emerging disease in Georgia and has been seen for two of the last three years. Stripe rust can have a potentially devastating effect on yield. Chemical options are available to control stripe rust however selection of fungicide should be made judiciously. Genetic resistance to stripe rust should be the best way to manage the disease. According to state breeders, there are several

varieties or breeding lines than have higher levels of resistance to the disease. Work is in progress to release newer varieties with resistance to stripe rust. A complete description, diagnosis and management is now available.
http://extension.uga.edu/publications/detail.html?number=C960 (circular 960)

Leaf and Glume Blotch

Lesions (spots) are initially water-soaked and then become dry, yellow, and finally brown. Lesions are generally oblong, sometimes containing small black spore producing structures called pycnidia. The lesions are often surrounded by a yellow halo. Lower leaves are generally more heavily infected, with lesions joining together to cause entire leaves to turn brown and die. If pycnidia are present on lower leaves when the uppermost leaf and the head begin to emerge, infective spores will move to the top of the plant in splashing rain even after a brief shower. Symptoms may not appear for 10-15 days on the top leaves or glumes on the head. By the time lesions are seen on the head, it is too late for effective fungicide use. Therefore, it is important to examine the lower leaves for lesions when making decisions about fungicide application, not just the top leaves. Lesions are first tan or brown on the upper portion of the glume while the lower part remains green. As the head matures, it becomes purplish to black in appearance from glume blotch. Leaf and glume blotch can reduce yield as much as 20% and reduce test weight due to grain shriveling even when disease severity is low.

Barley Yellow Dwarf

Barley yellow dwarf virus (BYDV) is probably the most widely distributed virus in wheat. It is estimated to reduce yields by 5 to 25% each year. The symptoms are variable and resemble nutritional problems or frost damage. Usually, the discoloration is characterized by various shades of yellow or reddening from the tips to the base and from the leaf margin to the midribs of the leaves. Some varieties have more yellow symptoms whereas others have red to purple discoloration. When infection begins early in the season, after heading, the uppermost leaf is often very upright. Severe infection usually causes some stunting and reduction in numbers of seeds per head. BYDV is transmitted by several aphid species. Aphids acquire the virus by feeding on infected plants for very short periods and then move to other uninfected plants. Infection can occur any time when viruliferous aphids multiply and migrate in fields. Crop rotation is less effective for barley yellow dwarf because aphids can transmit the virus between fields, and many grasses on which the aphids feed also harbor the virus. Barley yellow dwarf can cause severe losses in many Georgia fields, most often following a mild fall and winter, which allows aphids to be active and transmit the virus early in plant development. BYDV is present in nearly all fields each year. Disease severity depends on aphid populations and the proportion of aphids that can transmit the virus. Control of volunteer wheat and grassy weeds during the summer and along the edges of fields may slow initial infection. Planting during the latter part of the recommended period can delay fall infection. Resistant varieties and insecticide application to control aphids can reduce damage from barley yellow dwarf (see Insect Management).

Table 18. Optimum temperature and moisture for the major diseases affecting wheat grown in GA

DISEASE	OPTIMUM MOISTURE	OPTIMUM TEMPERATURE
Powdery Mildew[1]	High Humidity	59-72°F [2]
Leaf Rust	Free Moisture	59-72°F
Stripe Rust	Free Moisture	50-59°F
Leaf and Glume Blotch	Free Moisture	68-75°F
Take-All	Moist Soils	50-68°F
Fusarium Head Blight	High humidity at time of flowering	77-86°F

[1] Powdery mildew fungus does not need free moisture to develop.
[2] Temperatures above 77° F are not favorable for Powdery mildew fungal development.

Seedborne and Soilborne Diseases

Seedling Blights

Several fungal pathogens infect the seed as it matures, particularly when rains are frequent during seed development. Seed quality is reduced significantly, and germination is often problematic. Soil temperatures, which are higher early in the fall, also favor infection of the ungerminated seed and tissues of the germinating seedling by several species of soilborne *Pythium*. The combination of infection by both seedborne and soilborne fungi can result in severe pre- and post-emergence damping off. The result may be a substantially reduced stand that grows slowly, or it may be necessary to replant. Seedling blights can be reduced by planting good-quality seed and by the use of fungicide-treated seed (Table 19).

Smut Diseases

There are two smut diseases that affect wheat in Georgia. They usually cause only minor problems, but they can increase rapidly and cause serious losses if not controlled. Loose smut causes the tissues in the head to be replaced by masses of powdery spores. The fungus spores invade the embryo of the developing seed, and the fungus survives there until the seed germinates. Common bunt or stinking smut occurs rarely, but it can cause complete loss of a crop. The tissues of the head remain intact, but the seed is destroyed. The masses of smut spores are in 'bunt balls', which are held in the seed coat of the grain. Stinking smut gets its name from the foul odor it produces that is similar to rotting fish. The bunt balls are easily ruptured during harvest and millions of spores are deposited on the surface of healthy seeds. Spores germinate and invade the germinating seedling, and then the fungus grows systemically like loose smut. Smut spores are not toxic to animals or humans. These smut pathogens are only transmitted by seed. Planting certified seed is an effective method to control smut diseases because seed fields are carefully inspected. Seed treatment with systemic fungicides is

an inexpensive way to achieve nearly complete control of loose smut and common bunt (Table 19).

Table 19. Seed Treatment Fungicides for Control of Seedborne and Soilborne Diseases of Wheat

FUNGICIDE	CROP	RATE/100 LB SEED	REMARKS AND PRECAUTIONS
azoxystrobin Dynasty	Wheat and Barley	0.153-0.882 fl oz	For protection against common bunt and partial control of dwarf bunt. Where appropriate use in combination with Dividend extreme
captan Captan 400	Wheat, Barley, Oats, Rye	See label	Controls seedling blights. Does not control smuts.
carboxin + captan Enhance	Wheat, Barley, Oats	4.0 oz.	Controls loose smut, common and kernel bunt, seed rots and seedling diseases.
carboxin + ipconazole Rancona V100	Wheat, Barley, Oats, Rye	0.9 -1.5 fl oz	For control of seedborne and soilborne fungi
carboxin + thiram Vitavax 200 RTU-Vitavax-Thiram	 Wheat, Barley, Oats, Triticale Wheat, Oats, Barley	 2.0 oz. 2.0-4.0 oz.	Controls loose smut and stinking smut. Controls seedling blights. See label for specific rate for grains.
carboxin + PCNB + metalaxyl Prevail	Wheat, Oats, Barley	2.5 – 5.0 oz. wheat 1.6- 3.3 oz. oats	Controls loose smut, common and kernel bunt, seed rots and seedling diseases from Pythium and Rhizoctonia.
difenoconazole Dividend	Wheat	0.5-1.0 oz.	Controls loose smut and stinking smut.
difenoconazole + mefenoxam Dividend XL RTA Dividend XL Dividend Extreme	 Wheat Wheat Wheat	 5-10 oz. 1.0-.2.0 oz. 0.5-1.0 oz.	Controls loose smut, stinking smut, and Pythium damping-off. Grower and commercially applied.
fludioxonil Maxim 4FS	Barley, Millet, Oats, Rye, Sorghum, Triticale, Wheat	0.08-0.16 fl oz.	Controls Fusarium, Rhizoctonia, Helminthosporium and weakly pathogenic fungi such Aspergillus and Penicillium.
ipconazole Rancona 3.8 FS Rancona Apex	Wheat, Barley, Oats, Rye	3.8 FS =0.051 – 0.085 fl. oz. Apex= 5.0 – 8.3 fl. oz.	Controls loose smut, common and kernel bunt, seed rots and seedling diseases.
ipconazole + metalaxyl Rancona Pinnacle	Wheat, Barley, Oats, Rye	5.0 – 8.33 fl oz	Controls seed rot, damping off seed and soil borne fungi, loose smut, common and kernel bunt,
mefenoxan Apron XL, Apron XL-LS	Wheat, Barley, Millet, Oats, Rye, Sorghum, Triticale	0.042-0.08	Controls Pythium damping-off. Does not control smuts.
metalaxyl Allegiance Sebring Dyna-shield Belmont	Wheat, Barley, Millet, Oats, Rye, Sorghum, Triticale	See label	Controls Pythium damping-off. Does not control smuts.

metalaxyl + metconazole + Clothianidin NipsIt SUITE	Wheat, Oats, Barley	5.0 – 7.5 fl oz	Controls common smut, flag smut loose smut, seed decay fungi, Fusarium seed scab, Pythium seed rot and seedling. Early season Fusarium seedling dieback, early season Rhizoctonia root rot and early season common rot
penflufen Evergol Prime	Wheat, Oats, Barley	0.32 fl. oz.	Controls loose smut, common and kernel bunt, seed rots and seedling diseases
prothioconazole + penflufen + metalaxyl Evergol Energy	Wheat, Oats, Barley	1.0 fl. oz.	Controls loose smut, common and kernel bunt, seed rots and seedling diseases along with early suppression of powdery mildew, rust and glume/leaf blotch
sedaxane Vibrance	Wheat, Barley, Oats, Rye, Triticale	0.08-0.16 fl oz	Controls Loose smut, Seed decay seedling blight and damping-off caused by *Rhizoctonia solani*
sedaxane + difenconazole + mefenoxam Vibrance Extreme	Wheat, Barley, Oats, Rye, Triticale	2.8-5.6 fl oz	Controls smuts and bunts, general seed rot, seedling blight, root rot and damping-off caused by seed or soilborne *Fusarium* spp or *Rhizoctonia* spp, Seedling blight and root rot and damping-off caused by *Pythium* spp, seed borne *Septoria*, Septoria leaf blotch, Fusarium seed scab
sedaxane + difenconazole + fludioxonil + mefenoxam Vibrance Quattro	Wheat, Barley, Oats, Rye, Triticale	5.0 fl oz	Controls smuts and bunts, general seed rot, seedling blight, root rot and damping-off caused by seed or soilborne *Fusarium* spp or *Rhizoctonia* spp, Seedling blight and root rot and damping-off caused by *Pythium* spp, seed borne *Septoria*, Septoria leaf blotch, Fusarium seed scab
tebuconazole Raxil (tebuconazole can be found in various combinations with other fungicides, look for Sativa, Foothold, Raxil)	Wheat, Oats, Barley	3.5 to 4.6 fl. oz.	Controls loose smut and stinking smut. Controls seedling blights. Commercially-applied and drill-box formulations available.
thiram	Wheat, Barley, Rye	See label	Controls seedling blights. Does not control smuts. Can be used for drill-box treatment.
triadimenol Baytan 30 RTU Baytan-Thiram	Wheat, Barley, Oats, Rye All	0.75-1.5 oz. 4.5-9.0 oz.	Controls loose smut and stinking smut. Controls smuts and seedling blights.
triticonazole + metconazole Charter F	Wheat, Barley, Oats, Rye	5.4 fl. oz.	Controls loose smut, common and kernel bunt, seed rots and seedling diseases.

For information on CruiserMaxx Cereals (thiamethoxam + mefenoxam + difenconazole), CruiserMaxx Vibrance Cereals (sedaxane + thiamethoxam + mefenoxam + difenconazole), Cruiser Vibrance Quattro (thiamethoxam + mefenoxam + difenconazole + sedaxane + fludioxonil), and Gaucho XT (Imidaclorpid + metalaxyl + tebuconazole), Rancona Crest (ipconazole + metalaxyl + imidacloprid). See the Insect Management Section of this Guide. Commercial treatment of small grain seed is preferred, but a drill box treatment can be used with many formulations. Drill-box treatment may not give control to commercial treatment

Take-all Root and Crown Rot

The fungus responsible for this disease builds up in the soil when wheat is planted in the same field two or more years. Roots are damaged progressively during the winter and early spring. Shortly after heading infected plants wilt and die due to poor water movement from the rotted roots to the stems. The crown and lower stem turn black and plants are easily pulled from the soil. Areas of dead plants are circular or follow tillage patterns indicating movement of infested crop debris. Take-all is reduced by rotation with oats, fallow, or other non-cereal winter crops such as canola. Rotation with barley, rye, or triticale maintains the fungus in roots of these crops although they may not exhibit symptoms as severe as on wheat. Sorghum as a summer crop will reduce the disease in a subsequent wheat crop, whereas soybeans favor take-all. Other control measures include planting near the end of the recommended period to reduce fall infection and avoiding soil pH above 6.5.

Soilborne Mosaic and Spindle Streak Mosaic

The symptoms of soilborne mosaic range from mild green to a prominent yellow leaf mosaic. Plants may be stunted or rosette in shape. Symptoms are usually seen in late winter and early spring. New leaves may be mottled or exhibit streaks or flecking. Wheat spindle streak mosaic virus causes stunting and poor growth with yellow mottling and numerous elongated streaks on leaves. Leaf streaks are usually a light green to yellow. The discontinuous streaks run parallel to the leaf veins and taper to form a spindle shape. Both viruses are transmitted by a fungus, which survives in the soil and transmits the virus into the wheat roots. These diseases are typically a problem when soils remain wet during the late fall and winter. Spindle streak mosaic and soilborne mosaic are most common in fields planted to wheat for two or more years. Both viruses may occur together, and symptoms may intermingle. Crop rotation is an effective control method.

Other Diseases

Fusarium Head Blight (FHB) or Head Scab

Fusarium Head Blight is caused by the pathogen *Fusarium* spp /teleomorphs *Gibberella* spp and *Microdochium nivale*. FHB is a devastating and dangerous disease of wheat and barley with worldwide distribution. The disease causes yield loss, low-test weights, low seed germination, and contamination of grain with mycotoxins. A vomitoxin called deoxynivalenol (DON) is considered the primary mycotoxin associated with FHB. This mycotoxin is subject to regulatory limits by the U.S. Food and Drug Administration (FDA). While the incidence and severity of the infections of Fusarium head blight in 2018 were low due to weather patterns, high incidence and severity causing severe losses were registered in in previous years in Georgia. The fungus

requires warm (78-86 F consistently), humid/wet weather coinciding with wheat at flowering stages for infection to occur. *Fusarium* conidia and/or ascospores infection are most common at wheat anthesis. Fusarium Head Blight is best recognized on emerged immature heads where one or more or the entire head appears prematurely bleached (see image to right). Usually a pinkish/orange mycelium is present, which will develop dark fruiting bodies (perithecia). Diseased, bleached spikelets are sterile or contain shriveled/discolored seed (usually with a tint of pink or orange). For control, avoid rotation with other cereal crops, specifically corn (*Fusarium graminearum* also causes ear and stalk on corn) or sorghum. For more information on FHB visit http://www.scabusa.org and http://www.wheatscab.psu.edu. A complete description, diagnosis and management is now available.
http://extension.uga.edu/publications/detail.cfm?number=C1066 (circular 1066)

Fungicide Use

The decision about whether or not to use a fungicide needs to be made carefully. Fungicides do not increase yield. They only help preserve yield and test weight. If yield potential is low or there is no disease present at the critical time for fungicide application or conditions are not favorable for disease, there will be little benefit from fungicide application. If the price of wheat is low, there will be less profit from the use of fungicides. For these reasons, a decision guide has been developed to help you determine if fungicides will be beneficial. This guide makes no guarantee for an economic return on the fungicide investment. It will simply allow you to determine if fungicide treatment might help maintain yields.

To use this guide effectively, you must scout your wheat fields and be able to recognize the three major foliage diseases likely to reduce yields. Consult the UGA Extension publications Plant Pathology section at http://extension.uga.edu/publications.html Or the field crops section of the UGA Plant Pathology Extension site http://www.caes.uga.edu/departments/plant-pathology/extension/educational-materials/plant-disease-library.html for information on these and other wheat diseases. Some fungicide manufacturers have a color booklet on small grain diseases, which is helpful in disease identification. Begin scouting soon after the plants tiller and the stem begins to elongate. The leaves of plants should be observed at least once per week when jointing begins. Inspect plants twice each week from the time the flag (uppermost) leaf begins to emerge until flowering is complete. This is the most critical time to consider fungicide application. Inspect all the leaves, especially the lower leaves. Early in the season the lowest leaves may have symptoms while the younger upper leaves do not. Symptoms on the lower leaves are a good indication that the upper leaves will become infected, especially if rain or heavy dews occur during the next several weeks. Because disease symptoms may not appear until 7-12 days after infection begins, upper leaves that appear healthy may already be infected.

Fungicides can only be effective when you carefully select the fungicide with good activity against the disease(s) present (Table 20 and 21). They should be applied at the correct rate and time according to the label. Fungicides should be applied with enough water to get good

coverage: 5-7 gal/acre for aerial and 20-30 gal/acre for ground application. Use of a spreader-sticker will help improve leaf retention and fungicide performance. When applying fungicides always read the label and comply with the instructions and restrictions listed.

Generally, the most effective time to apply fungicides is from flag leaf emergence to completion of heading but be certain to follow any label restrictions concerning time of application, the number of applications, and total amount of fungicide that can be applied per season.

Infectious fungi sometimes develop resistance to particular fungicides, especially when a product is used repeatedly without alternating with chemically unrelated fungicides. When fungicide resistance develops, there is no value in increasing rates, shortening intervals between sprays, or using other fungicides with similar modes of action. Several general strategies are recommended to minimize the risk of fungicide resistance. First, don't rely on fungicides alone for disease control. Avoid using wheat varieties that are highly susceptible to common diseases. Follow good disease management practices to reduce the possibility of fungicide resistance. Limit the number of times at-risk fungicides are used during a growing season. Alternate at-risk fungicides with different fungicide groups. These are general principles that can help to reduce but not eliminate risk. A fungicide-resistant pathogen population can still develop when these principles are practiced.

Table 20. Fungicides for Wheat Foliar Diseases.

Disease	Chemical and Formulation	Rate Product Per Acre	Remarks and Precatuions	FRAC	REI
Stagonospora Leaf and Glume Blotch, Leaf Rust, Stripe Rust, Powdery Mildew, Tan Spot	azoxystrobin** Quadris Equation Satori	6.2-10.8 oz. 4.0-12.0 fl oz	Apply after Feekes 6 but not later than Feekes 10.5. Do not harvest treated wheat for forage. A crop oil concentrate adjuvant may be added at 1.0% v/v to optimize efficacy	11	4 hrs
	azoxystrobin + cyproconazole Azure Xtra	3.5 -6.8 fl oz	Apply product at 3.5 oz /A in the spring at @ Feekes 5. Apply at 5-6.8 fl oz/A between Feekes 8-10.51.	11+3	12 hrs
	azoxystrobin + propiconazole Quilt, QuiltXcel, Avaris, Trivapro B	7-14 oz	Applications may be made no closer than a 14-day interval. Quilt and QuiltxXcel can be applied up to Feekes growth stage 10.5. QuiltXcel has a higher rate of azoxystrobin. Low rates of Quilt and QuiltXcel are used for spring suppression of early season diseases. 10.5 fl oz and above are used for flag leaf protection and maximizing yield potential. Trivapro A + Trivapro B= Trivapro co-pack. Do not apply more than 28 fl oa /A of Trivapro B per year	11+3	12 hrs
	azoxystrobin + tebuconazole Custodia	6.4-8.6 fl oz	Should be applied prior to disease development up to late head emergence (Feekes 10.5). Do not apply after this stage	11+3	12 hrs
	azoxystrobin + flutriafol Topguard EQ	4.0-7.0 fl oz	Apply preventatively or when conditions are favorable for disease development. Repeat as necessary if conditions are favorable for disease development. Do not apply past Feekes 10.54..An adjuvant may be added at recommended rates.	3+11	12 hrs

	benzovindiflupyr Trivapro A	4.0 fl oz	Combining Trivapro A and Trivapro B co-pack. Apply in spring for early disease control or Feekes 8 through Feekes 10.5.4 for disease control on flag leaf. Make applications no closer than 14 days apart. Do not apply more than 14 fl oz/A of Trivapro A per year.	7	12 hrs
	benzovindiflupyr + azoxystrobin + propiconazole Trivapro SE	9.4 -13.7 fl oz	For disease control on the flag leaf, apply from Feekes 8 (Zadoks 37) through Feekes 10 (Zadoks 45). Protecting the flag leaf is important for maximizing the potential yield. Highest yields are normally obtained Trivapro Fungicide is applied when the flag leaf is 50% to fully emerged. Trivapro Fungicide can be applied through full head emergence (Feekes growth stage 10.5.4). Do not apply after this stage to avoid possibly illegal residues.	7+11+3	12 hrs
	fluoxapyroxad + pyraclostrobin Priaxor	4-8 fl oz.	Apply no later than the beginning of flowering (Feekes 10.5, Zadok's 59). Maximum number of applications per season=2	7+11	12 hrs
	fluoxapyroxad + pyraclostrobin + propiconazole Nexicor	7-13 fl oz	For optimal disease control, begin applications of Nexicor prior to disease development. To maximize yield potential it is important to protect the flag leaf. Apply Nexicor immediately after flag leaf emergence, no later than the beginning of flowering (Feekes 10.5, Zadok's 59).	7+11+3	12 hrs
	fluoxastrobin Evito	2-4 fl oz.	For optimum results, begin applications preventatively and continue on a 14 to 21 day interval. Do make more than two sequential applications. Apply prior to disease development from Feekes 5 (Zadok's 31) up to late head emergence at Feekes 10.5 (Zadok's 59)	11	12 hrs
	fluoxastrobin + tebuconazole Evito T	4-6 fl oz	Apply a maximum of two applications per season Apply no later than Feekes growth stage 10 5. For optimum results, apply the rst application at approximately Feekes growth stage 5 (Zadoks 31) (shooting-pseudostem erected) and a second application no later than Feekes growth stage 10 5 (Zadoks 54) (heading completed)	11 + 3	12 hrs
	fluoxastrobin + flutriafol Fortix Preemtor SC	2-3 fl oz. 4-6 fl oz	For early season control Apply Fortix when flag leaf is 50% to fully emerged. Apply preventative when conditions for disease are favorable for development. *Supplemental labeling	11 + 3	12 hrs
	metconazole Caramba	10-14 oz.	Maximum number of applications per season=2; Minimum time from application to harvest=30 days	3	12 hrs
	picoxystrobin Aproach	3-4 fl oz 6-12 fl oz	For early season preventive disease control. Begin applications of Aproach prior to disease development and continue on a 7- to 14-day interval, depending on the targeted disease. Use higher rate and shorter interval when disease pressure is high.	11	12 hrs

	picoxystrobin + cyproconazole Aproach Prima	3.4 fl oz 3.4 -6.8 fl oz	For early season preventive disease control. Begin applications of Aproach-Prima prior to disease development and continue on a 7- to 14-day interval, depending on the targeted disease. Use higher rate and shorter interval when disease pressure is high	11+3	12 hrs
	propiconazole Tilt Propimax	4 oz.	Tilt can be applied until heading stage (Feekes 10.5). Do not apply Tilt after this growth stage to avoid possible illegal residues.	3	12 hrs
	propiconazole + trifloxystrobin Stratego	10 oz	Do not apply more than 2 applications of Stratego per season. Do not apply after Feekes 10.5	3+11	12 hrs
	prothioconazole Proline	4.3-5 fl oz.	For optimum disease control, the lowest labeled rate of a spray surfactant should be tank mixed with Proline. Up to two applications of Proline can made per year.	3	12 hrs
	prothiconazole + tebuconazole Prosaro	6.5 - 8.2 fl. oz.	Begin applications of Prosaro preventively when conditions are favorable for disease development. For optimum disease control, the lowest labeled rate of a spray surfactant should be tank mixed with Prosaro	3+3	12 hrs
	prothioconazole + trifloxystrobin Stratego YLD Delaro 325 SC	4 fl oz 8.0 fl oz	Begin applications preventively when conditions are favorable for disease development. Do not apply more than 2 applications per season. Do not apply after Feekes growth stage 10.5. Do not apply within 35 days of harvest	3+11	12 hrs
	pydiflumetofen propiconazole Miravis Ace	13.7 fl oz	Protecting flag leaf is important for maximizing the potential yield	7 + 3	12 hrs
	pyraclostrobin Headline	6-9 oz	Apply no later than Feekes 10.5	11	12 hrs
	pyraclostrobin + metconazole Twinline	7-9 fl oz.	Do not apply more than 2 applications per season. Do not apply after Feekes 10.5	11+3	12 hrs
	tebuconazole Folicur, several other with tebuconazole as active ingredient. Check label of specific products	4 fl oz.	Folicur is not longer manufactured (2009). No end-user restrictions for disease control. Use until supply lasts. Not labeled for Powdery mildew control. For all tebuconazole products, a maximum of 4 fl oz may be applied per acre per season	3	12 hrs
	tebuconazole + trifloxystrobin, Absolute Absolute Maxx	3-5 fl oz.	Begin applications preventively when conditions are favorable for disease development. For optimum disease control apply 5 fl oz at flag leaf stage (Feekes 8-9). For early season suppression of Tan Spot, Leaf Blight and Powdery Mildew, apply at 3-4 oz. Do not apply more than 5 fl oz per season. Do not apply after Feekes growth stage 10.5.2. Do not apply within 35 days of harvest. Do not use with adjuvants.	3+11	12 hrs

Economic yield response to controlling wheat diseases is most likely to occur in fields with yield potentials of more than 50 bu/A and varieties with fair to poor resistance. ***Always follow label instructions, recommendations and restrictions***.

Table 21. Fungicides for Fusarium Head Blight

Active ingredient	Product	Rate/A (fl. oz)	Head scab	Harvest Restriction
Metconazole 8.6%	Caramba 0.75 SL	13.5 - 17.0	G	30 days
Propiconazole 41.8%	Tilt 3.6 EC	4.0	P	Feekes 10.5
Prothioconazole 41%	Proline 480 SC	5.0 - 5.7	G	30 days
*Tebuconazole 38.7%	Folicur 3.6 F	4.0	F	30 days
Prothioconazole 19% Tebuconazole 19%	Prosaro 421 SC	6.5 - 8.2	G	30 days
Pydiflumetofen 13.7% Propiconazole 11.4%	Miravis Ace SE	13.7	G	Feekes 10.5.4

Efficacy categories; P = Poor, F = Fair, VG = Very Good, E = Excellent. Timing of fungicide application is crucial for the control of FHB. Research indicates that products within the triazole class of fungicides are most effective if applied at early flowering (Feekes 10.5.1). **Strobilurin fungicides are not recommended for management of FHB. Strobilurin fungicides can increase the DON content of FHB infected grain.** * A maximum of floz of tebuconazole containing products may be applied per acre per crop season.

Wheat Production Budgets: 2022-2023

Amanda Smith

WHEAT FOR GRAIN, CONVENTIONAL

GEORGIA, 2022-23

[[Due to extreme volatility in input markets, prices may change rapidly. These are current as of October 2022. You are encouraged to enter your own prices to best estimate your 2023 cost of production.]]

Estimated Costs and Returns

Expected Yield: **55** bushel Your Yield ________

Variable Costs**	Unit	Amount	$/Unit	Cost/Acre	$/bushel	Your Farm
Seed	pounds	90	$ 0.49	$ 44.10	$ 0.80	______
Lime	ton	0.25	$ 60.00	$ 15.00	$ 0.27	______
Fertilizer						
Nitrogen	pounds	80	$ 1.07	$ 85.60	$ 1.56	______
Phosphate	pounds	40	$ 0.82	$ 32.80	$ 0.60	______
Potash	pounds	40	$ 0.78	$ 31.20	$ 0.57	______
Weed Control	acre	1	$ 27.82	$ 27.82	$ 0.51	______
Insect Control	acre	1	$ 1.43	$ 1.43	$ 0.03	______
Disease Control	acre	1	$ 16.50	$ 16.50	$ 0.30	______
Disease Spray by Air	acre	1	$ 8.00	$ 8.00	$ 0.15	______
Preharvest Machinery						
Fuel	gallon	3.3	$ 4.50	$ 15.02	$ 0.27	______
Repairs and Maintenance	acre	1	$ 8.72	$ 8.72	$ 0.16	______
Harvest Machinery						
Fuel	gallon	3.0	$ 4.50	$ 13.63	$ 0.25	______
Repairs and Maintenance	acre	1	$ 6.37	$ 6.37	$ 0.12	______
Labor	hours	0.7	$ 13.50	$ 10.07	$ 0.18	______
Irrigation*	applications		$ 10.60	$ -	$ -	______
Crop Insurance	acre	1	$ 15.00	$ 15.00	$ 0.27	______
Land Rent	acre	1	$ -	$ -	$ -	______
Interest on Operating Capital	percent	$ 165.63	6.50%	$ 10.77	$ 0.20	______
Drying - 2 Points	bushel	60	$ 0.09	$ 5.43	$ 0.10	______
Total Variable Costs:				**$ 347.45**	**$ 6.32**	

Fixed Costs	Unit	Amount	$/Unit	Cost/Acre	$/bushel	Your Farm
Machinery Depreciation, Taxes, Insurance and Housing						
Preharvest Machinery	acre	1	$ 23.90	$ 23.90	$ 0.43	______
Harvest Machinery	acre	1	$ 30.17	$ 30.17	$ 0.55	______
Irrigation	acre	0	$ 135.00	$ -	$ -	______
General Overhead	% of VC	$ 347.45	5%	$ 17.37	$ 0.32	______
Management	% of VC	$ 347.45	5%	$ 17.37	$ 0.32	______
Owned Land Cost, Taxes, Cash Payment, etc.	acre	1	$ -	$ -	$ -	______
Other ______________	acre	1	$ -	$ -	$ -	
Total Fixed Costs				**$ 88.82**	**$ 1.61**	
Total Costs Excluding Land				**$ 436.27**	**$ 7.93**	
Your Profit Goal			**$**	______	**/bushel**	
Price Needed for Profit			**$**	______	**/bushel**	

*Average of diesel and electric irrigation application costs. Electric is estimated at $7/appl and diesel is estimated at $18/appl when diesel costs $4.50/gal.

Developed by Amanda Smith.

UGA extension

Sensitivity Analysis of WHEAT FOR GRAIN, CONVENTIONAL

Net Returns Above Variable Costs Per Acre

Varying Prices and Yields (bushel)

	-25%	-10%	Expected	+10%	+25%
Price \ bushel/Acre	41	50	55	61	69
$6.00	**-$99.95**	**-$50.45**	**-$17.45**	**$15.55**	**$65.05**
$6.25	**-$89.64**	**-$38.08**	**-$3.70**	**$30.67**	**$82.24**
$6.50	**-$79.33**	**-$25.70**	**$10.05**	**$45.80**	**$99.42**
$6.75	**-$69.01**	**-$13.33**	**$23.80**	**$60.92**	**$116.61**
$7.00	**-$58.70**	**-$0.95**	**$37.55**	**$76.05**	**$133.80**
$7.25	**-$48.39**	**$11.42**	**$51.30**	**$91.17**	**$150.99**
$7.50	**-$38.08**	**$23.80**	**$65.05**	**$106.30**	**$168.17**

Estimated Labor and Machinery Costs per Acre

Preharvest Operations

Operation	Acres/Hour	Number of Times Over	Labor Use** (hrs/ac)	Fuel Use (gal/ac)	Repairs ($/ac)	Fixed Costs ($/ac)
Disk Harrow 32' with Tractor (180-199 hp) MFWD 190	16.3	1	0.08	0.60	$ 1.97	$ 5.72
Chisel Plow-Rigid 24' with Tractor (180-199 hp) MFWD 190	13.0	1	0.10	0.75	$ 1.55	$ 4.34
Grain Drill 15' with Tractor (180-199 hp) MFWD 190	8.0	1	0.16	1.23	$ 3.47	$ 9.78
Spray (Broadcast) 60' with Tractor (120-139 hp) 2WD 130	35.5	4	0.14	0.75	$ 1.72	$ 4.06
					$ -	$ -
					$ -	$ -
Total Preharvest Values			0.47	3.34	$ 8.72	$ 23.90

****Add ~$3.70/ac in variable costs if you seed with spin spreader and disking it into the field as opposed to using a grain drill. Fixed costs would decrease by ~$2/ac.

Harvest Operations

Operation	Acres/Hour	Number of Times Over	Labor Use*** (hrs/ac)	Fuel Use (gal/ac)	Repairs ($/ac)	Fixed Costs ($/ac)
Header Wheat/Sorghum 22' Rigid with Combine (300-349 hp) 325 hp	7.9	1	0.16	2.11	$ 4.25	$ 24.31
Grain Cart Wht/Sor 500 bu with Tractor (180-199 hp) MFWD 190	10.6	1	0.12	0.92	$ 2.12	$ 5.86
Total Harvest Values			0.28	3.03	$ 6.37	$ 30.17

*** Includes unallocated labor factor of 0.25. Unallocated labor factor is percentage allowance for additional labor required to move equipment and hook/unhook implements, etc.

Developed by Amanda Smith.

WHEAT FOR GRAIN, INTENSIVE MANAGEMENT

GEORGIA, 2022/23

[[Due to extreme volatility in input markets, prices may change rapidly. These are current as of October 2022. You are encouraged to enter your own prices to best estimate your 2023 cost of production.]]

Estimated Costs and Returns

Expected Yield: **75** bushel Your Yield ______

Variable Costs	Unit	Amount	$/Unit	Cost/Acre	$/bushel	Your Farm
Treated Seed	pounds	125	$ 0.53	$ 66.25	$ 0.88	
Lime	ton	0.25	$ 60.00	$ 15.00	$ 0.20	
Fertilizer						
Nitrogen	pounds	120	$ 1.07	$ 128.40	$ 1.71	
Phosphate	pounds	50	$ 0.82	$ 41.00	$ 0.55	
Potash	pounds	60	$ 0.78	$ 46.80	$ 0.62	
Weed Control	acre	1	$ 35.82	$ 35.82	$ 0.48	
Insect Control	acre	1	$ 1.43	$ 1.43	$ 0.02	
Disease Control**	acre	1	$ 20.10	$ 20.10	$ 0.27	
Disease Spray by Air	acre	1	$ 8.00	$ 8.00	$ 0.11	
Preharvest Machinery						
Fuel	gallon	7.0	$ 4.50	$ 31.39	$ 0.42	
Repairs and Maintenance	acre	1	$ 16.21	$ 16.21	$ 0.22	
Harvest Machinery						
Fuel	gallon	3.0	$ 4.50	$ 13.63	$ 0.18	
Repairs and Maintenance	acre	1	$ 6.37	$ 6.37	$ 0.08	
Labor	hours	1.2	$ 13.50	$ 16.50	$ 0.22	
Irrigation*	applications		$ 10.60	$ -	$ -	
Crop Insurance	acre	1	$ 12.00	$ 12.00	$ 0.16	
Land Rent	acre	1	$ -	$ -	$ -	
Interest on Operating Capital	percent	$ 229.45	6.50%	$ 14.91	$ 0.20	
Drying - 2 Points	bushel	82	$ 0.09	$ 7.41	$ 0.10	
Total Variable Costs:				**$ 481.22**	**$ 6.42**	

Fixed Costs	Unit	Amount	$/Unit	Cost/Acre	$/bushel	Your Farm
Machinery Depreciation, Taxes, Insurance and Housing						
Preharvest Machinery	acre	1	$ 46.50	$ 46.50	$ 0.62	
Harvest Machinery	acre	1	$ 30.17	$ 30.17	$ 0.40	
Irrigation	acre	1	$ 135.00	$ 135.00	$ 1.80	
General Overhead	% of VC	$ 481.22	5%	$ 24.06	$ 0.32	
Management	% of VC	$ 481.22	5%	$ 24.06	$ 0.32	
Owned Land Cost, Taxes, Cash Payment, etc.	acre	1	$ -	$ -	$ -	
Other ______	acre	1	$ -	$ -	$ -	
Total Fixed Costs				**$ 259.79**	**$ 3.46**	
Total Costs Excluding Land				**$ 741.01**	**$ 9.88**	
Your Profit Goal				**$ ______**	**/bushel**	
Price Needed for Profit				**$**	**/bushel**	

*Average of diesel and electric irrigation application costs. Electric is estimated at $7/appl and diesel is estimated at $18/appl when diesel costs $4.5/gal.

** If disease is expected to be a problem, add an additional $12-15/acre for chemical and application costs.

Developed by Amanda Smith.

Sensitivity Analysis of WHEAT FOR GRAIN, INTENSIVE MANAGEMENT

Net Returns Above Variable Costs Per Acre

Varying Prices and Yields (bushel)

	-25%	-10%	Expected	+10%	+25%
Price \ bushel/Acre	56	68	75	83	94
$6.00	**-$143.72**	**-$76.22**	**-$31.22**	**$13.78**	**$81.28**
$6.25	**-$129.65**	**-$59.34**	**-$12.47**	**$34.41**	**$104.72**
$6.50	**-$115.59**	**-$42.47**	**$6.28**	**$55.03**	**$128.16**
$6.75	**-$101.53**	**-$25.59**	**$25.03**	**$75.66**	**$151.60**
$7.00	**-$87.47**	**-$8.72**	**$43.78**	**$96.28**	**$175.03**
$7.25	**-$73.40**	**$8.16**	**$62.53**	**$116.91**	**$198.47**
$7.50	**-$59.34**	**$25.03**	**$81.28**	**$137.53**	**$221.91**

Estimated Labor and Machinery Costs per Acre

Preharvest Operations

Operation	Acres/Hour	Number of Times Over	Labor Use*** (hrs/ac)	Fuel Use (gal/ac)	Repairs ($/ac)	Fixed Costs ($/ac)
Plow 4 Bottom Switch with Tractor (180-199 hp) MFWD 190	2.3	1	0.54	4.20	$ 8.61	$ 25.93
Disk Harrow 32' with Tractor (180-199 hp) MFWD 190	16.3	1	0.08	0.60	$ 1.97	$ 5.72
Grain Drill 15' with Tractor (180-199 hp) MFWD 190	8.0	1	0.16	1.23	$ 3.47	$ 9.78
Spray (Broadcast) 60' with Tractor (120-139 hp) 2WD 130	35.5	5	0.18	0.94	$ 2.15	$ 5.07
					$ -	$ -
					$ -	$ -
Total Preharvest Values			0.95	6.98	$ 16.21	$ 46.50

***Add ~$3.70/ac in variable costs if you seed with spin spreader and disking it into the field as opposed to using a grain drill. Fixed costs would decrease by ~$2/ac.

Harvest Operations

Operation	Acres/Hour	Number of Times Over	Labor Use*** (hrs/ac)	Fuel Use (gal/ac)	Repairs ($/ac)	Fixed Costs ($/ac)
Header Wheat/Sorghum 22' Rigid with Combine (300-349 hp) 325 hp	7.9	1	0.16	2.11	$ 4.25	$ 24.31
Grain Cart Wht/Sor 500 bu with Tractor (180-199 hp) MFWD 190	10.6	1	0.12	0.92	$ 2.12	$ 5.86
Total Harvest Values			0.28	3.03	$ 6.37	$ 30.17

*** Includes unallocated labor factor of 0.25. Unallocated labor factor is percentage allowance for additional labor required to move equipment and hook/unhook implements, etc.

Developed by Amanda Smith.